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AGRI-Life

Transforming agriculture in Bundelkhand through rainbow revolution.....

Strategies for doubling the income of the farmers of Bundelkhand region - Goal 2022

Rani Lakshmi Bai Central Agricultural University
Jhansi-284 003 (U.P.) India

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Director Education
E-mail : directoreducation.rlbcau@gmail.com

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From Vice Chancellor's Desk.....

It gives me immense pleasure to know that Agri-Life on the theme "Strategies for doubling the income of the farmers in Bundelkhand region : Goal 2022" has brought out second issue in order to enhance the income for sustainable livelihood of farmers. Historically, India has been an agrarian country. The agriculture and allied sectors keep on with the largest source of livelihood security for millions of households in India. One of the brightest spots in the history of Indian agriculture was between the 1950 and the late 1960s – the Green Revolution resulted in incremental increase in production of food grains, especially wheat and paddy. However, there is a dire need to move away from the agri-production based model to a rural manufacturing based model. Especially, due to high demand for food and other farm products in the semi-arid region like Bundelkhand has led to the tremendous intensification of agriculture. In this region native vegetation is represented by a variety of species such as grasses and grass like plants, shrubs and trees. Many people in Bundelkhand region are higher reliance on agricultural and allied activities. However, in this region farmers are forced to produce more from less. With rising population; there is a relentless of diversification of land and water resources for non-agricultural purposes.

India has to increase agricultural production by almost 70% in the next three decades to cater the demands of the projected 9.7 billion populations by 2050. Hence, first we need to define our target. Doubling farmers' income implies increasing income from crop cultivation. The focus must shift from increasing per acre productivity to gainfully employing farm households in other farm-related activities. There is the need to involve the under-employed adults in rural households in low-skilled non-crop activities that integrate output from these activities into the existing or future markets. Augmenting water availability and efficiency, agriculture productivity, risk mitigation strategies and innovations on new models may be the ways to step up progress further.

Therefore, development, diffusion and adoption of innovation-led technologies and food supply chain are important in Bundelkhand region in order to double the farmer's income. Further, utilization of suitable strategies as genetic enhancement, innovations in precision agriculture, natural resource management, climate smart agriculture, mechanization, farmer market linkage, value chain and post-harvest management would help in increasing farm income in this region.

I am confident that, the articles in the current issue of Agri-Life are highlighting meaningful strategies as well as effective learning to the different stakeholders for innovations to productivity, profitability and sustainability in this region.

(Arvind Kumar)
Vice Chancellor

Editorial

Is doubling India's farmers' income a distant dream or doable?

The Indian economy has been agrarian to large extent as the major segment of its population still resides in villages. Bundelkhand region of India is being rain fed; its productivity heavily depends on climate and monsoon rainfall. The crisis we see today was building for decades, and skipped our notice – farming has lost the joy and has become a source of income for those who cannot opt for any other means to earn. The Prime Minister's vision of doubling farmer's income by 2022 is worth serious attention. At the current 3-per-cent growth rate it would take 25 years to double farmers' income. Doubling farmer's income in this region requires that the on-going and previously achieved rate of growth in farm income has to be sharply accelerated. Therefore, strong measures will be needed to harness all possible sources of growth in farmers' income within as well as outside agriculture sector.The major sources of growth operating within agriculture sector are: improvement in productivity, resource use efficiency or saving in cost of production, increase in cropping intensity and diversification towards high value crops. The sources outside agriculture include: shifting cultivators from farm to non-farm occupations and improvement in terms of trade for farmers or real prices received by farmers.

Solutions for doubling household income must be centered on development of new models, practices, recommendations and strategies to double the income of farmer's by 2022. Science, technology and new knowledge can play crucial roles in supporting livelihoods for the vulnerable. Identifying the right kind of tech support is crucial to development progress, even more so in the context of agriculture. The development of agricultural innovation system is closely related to agricultural production and rural economy. The most important strategy is to educate farmers about the required input materials such as seeds and water for irrigation as well as other agri-inputs for nutrients/diseases or pests management to augment agricultural productivity in sustainable manner. However, adopting Integrated Pest Management (IPM), Integrated Nutrients Management (INM) and Integrating Farm Managaement (IFM) in the form of Biovillage/Biovalleys in a cooperative model employing modern agro-technologies/rural biotechnologies to increase farmer income while protecting the environment, can prove to be game changer strategies to double the income.

Therefore, the strategies for doubling farmers income in this region includes; Increase in productivity of crops, increase in production of livestock, improvement in efficiency of input use (cost saving), increase in crop intensity, diversification towards high value crops, improved price realization by farmers and shift of cultivators to non-farm practices. Research institutes should come with technological breakthroughs for shifting production frontiers and raising efficiency in use of inputs. Similarly, practices like direct seeded of crops, zero tillage, raised bed plantation and ridge plantation allow technically highly efficient farming. However, these technologies developed by the public sector have very poor marketability. They require strong extension for the adoption by farmers. R&D institutions should also include in their packages grassroots level innovations and traditional practices which are resilient, sustainable and income enhancing will result in sizeable increase in farmers' income in this region.

The theme of second issue of Agri-Life is on “Strategies for doubling the income of farmers in Bundelkhand region” I am confident that the present issue having several articles will provide innovative dimensions to the farming community and other stakeholders in this regard.

(Anil Kumar)
Editor-in-Chief

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Bio village: An integrated model of farming system and village development for doubling the income of farmers in Bundelkhand region

Anil Kumar

Effective implementation of proposed concept of integrated farming and village development requires inputs from different but inter-linked disciplines along with re-exploring the recycling and efficient utilization of synergisms between the different enterprises. In order to understand the essence of integrated model of farming system and village development, one must see the macro-economic background. The establishment of a Centre for bio village development will help in strengthening the efforts towards the applications of integrated approach through innovation in farming system designs and use of innovative and complimentary approaches in an integrated fashion for the development of rural sectors. The need for knowledge driven integrated technology centre with finest State-of-art facilities will significantly contribute in enhancing the agricultural productivity and expedite to solve need based research problems as well as industrial development in Bundelkhand. Apart from developing an integrated centre for training and research, the centre will help in producing trained human resource in the area of sustainable agriculture that will cater to the specific demands of the industry. The centre will also have a student's and rural youth entrepreneur skill development component that will help to generate entrepreneurial skills and thus employability. Replication of such models in rural areas could be milestone in augmenting the income of farmers in Bundelkhand.

Introduction

"India's soul lives in its villages". This statement by our father of nation, Mahatma Gandhi, reflects the importance and role of villages in the socio-economic development of our country. It has been estimated that more than 70% of Indian population live in villages which constitute "rural India".

The rural economy in India is based upon the agriculture which is main stay of economy in our country. The agriculture, in India, has vital demand and supply links with various industries. Hence, the growth of rural economy is essential for overall economic growth of our country. Unfortunately, whereas the urban areas/cities have grown tremendously in last twenty years, the rural areas have lagged behind in terms of socio economic developments. The agriculture based rural economy is currently contributing to only 23 % of GDP of the country while engaging 70% of population. The slow growth rate of rural economy is due to various problems of rural areas such as malnutrition, unemployment, illiteracy and lack of basic facilities which is prompting a large proportion of rural masses mainly rural youths to lose interest in agriculture and migrate to urban areas in search of employment.

Way back in 1936, Mahatma Gandhi envisioned the programmes of rural reconstruction by which economic and social progress of villages could be accelerated. He wanted each village to operate as self sufficient and independent unit which can meet every villager's basic necessities with regard to food, cloth and other facilities. Such vision prompted him to promote "Khadi" and cottage village industries to provide employment opportunities to the rural youths. In the present scenario, in order to realize this vision of Gandhiji, once again there is challenge for creation of new employment avenues which could uplift rural areas, prevent migration of rural youths and enhance rural life besides boosting up rural economy.

Seventy years since India gained independence, what has really changed for the farmers of today? During this crucial post-independence period, agriculture contributed 45 per cent of the country's GDP, employing the majority of Indian workers. A period of stagnancy was witnessed after an impressive increase in agricultural production during "Green Revolution" but the socio-economic conditions of farmers remain unchanged. There is the need to involve the under-employed adults in rural

Director Research, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh 284003
E-Mail :sharma.ar@rediffmail.com

households in low-skilled non-crop activities that integrate output from these activities into the existing or future markets. Central to this approach is creating a market-place that supports a rural enterprise which is partly agricultural and partly non-agricultural. As a result, bio village is emerging as a worthwhile solution to foster the agricultural development and conserve the ecological balance as well. This bio economy based model could ensure the benefits to farmers for their economic gains.

Challenges and issues:

The fruits of 'green revolution' in India are now declining and there is an urgent need to augment the agricultural resources for sustaining the increasing anthropogenic pressures. The farm productivity increases are now flattening in Indian agriculture due to serious constraints to productivity because of small holdings, the subsistence nature of farming, vagaries of the weather, limited water supply *etc*. In addition to the above, in the State of Uttar Pradesh a vast treasure of natural wealth remains unutilized or underutilized, which has the potential to upgrade the socio-economic status of the common masses in the Bundelkhand region. Today in Bundelkhand region, there are as many people below the poverty line, having small land holdings and rural youths are also migrating from their native to urban areas. If government machinery will convince with the idea of establishment of centre of bio-village development and management then it will prove a resounding success in the up-liftment of socio-economic development of rural areas in general and agricultural sectors in Bundelkhand region. A significant portion of the entire population deeply depends on this sector to earn their livelihood. But the rising population, disappearance of cultivable lands and livelihood security are the major challenges to address these issues in an environment friendly way. Use of improved technologies under integrated farming system complementing the efforts of traditional agricultural scientists, to achieve high productivity in a sustainable manner, could be a solution to the problem of food and nutritional security and could scale up the employability status in the state of Uttar Pradesh.

Most of them are resource poor, illiterate, live in diverse risk prone areas. The problems faced by them includes high agricultural loans, farming not secured by any financial/insurance institution, no price support, poor marketing facilities and lack of technical knowhow. With the state's limitations in land and water resources, yields need to be improved through scientific transformation and modernization of agriculture. Thus, the development policies for the agriculture sector of the state in particular have to be oriented towards marginal and small landholders. For sustainable development, additional investment is crucial. The prime objective of the development of the agriculture system is to increase sustainability of this sector in such a manner that it provides a better livelihood option and makes the population dependent on it move from subsistence farming to a well-knit higher-income farming system and alternatives to the farming system in a diversified manner.

Parallel development of integrated farming system and Biovillage

The 21st century agriculture in India is facing the challenge to achieve sustainable food security with shrinking land resources to meet the requirement of the prognosticated population of more than 1.2 billion in the country. Because of declining per capita availability of land in India, there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure regular income to the farmer. Further, modest increments in land productivity are no longer sufficient for the resource-poor farmers.

Hence, intelligent management of available resources, including optimum allocation of resources, is important to alleviate the risks related to land sustainability. Moreover, proper understanding of interactions and linkages between the components would improve food security, employment generation as well as nutritional security. This approach can be transformed into a farming system that integrates crops with enterprises such as – agroforestry; horticulture; cow, sheep and goat rearing; fishery; poultry and duck rearing; mushroom production; sericulture; biogas and vermicompost production– to increase the income and improve the standard of living of small and marginal farmers. The challenge of such an

integrated farming system (IFS) is to upgrade technological and social disciplines on a continuous basis and integrate these disciplines to suit the region and the farm families in a manner that will ensure increased production with stability, ecological sustainability and equitability besides income generation.

The farming system approach makes the system so holistic that recycling of farm wastes, crop residues and remains of different farm enterprises; fulfill about 90 % of the nutritional requirement of system itself. IFS also advocates self sufficiency in nutrient budgeting therefore on one hand reduce the dependency on external inputs and on other provide balanced and rich nutrition to the system. Interestingly, the system will produce food, feed, fodder, milk, fuel etc. and other nutrition requirement of the family. However it is not possible to suggest a single/common model of farming system for each and every farm situation as it will differ in size and preposition of the enterprises to be integrated with the existing farming system and according to farmer's resources and his family requirements. Based on characterization survey and experience gained in the field of specialization, a integrated farming module consisting of crops + livestock/ aquaculture + horticulture/ agroforestry + post harvest handling and value addition was standardized for small and marginal farmers with assured irrigation.

Concept of Biovillage development

Biovillage development and management approach represents a collaborative development “pro-nature, pro-women, pro-poor". It provides the tools and technical assistance to increase job-led economic growth rooted in the principles of ecology, equity, energy efficiency and employment generation which ultimately augment the household income of rural youths. The Biovillage model for rural development provides an alternative as it pays concurrent attention to natural resource conservation, productivity improvement and poverty eradication. It also promotes strategically sustainable agricultural development, improved nutrition and food security, and also ensures women's participation. The bio-village model of rural development is proposed and designed for small family enterprises. The project transmits agronomic, animal husbandry, poultry, fishery, and horticultural knowledge, as well as giving organizational empowerment and some financial help to poor people including women who want to take part in it.

A Biovillage, the latest in social and cultural innovation to meet the challenges of local agriculture in the twenty first century, is a village or territory where a community of people harmoniously coexists with nature to foster a bio-diversified ecological balance. In this environment, they cultivate organic farming, using natural fertilizers and seed cultivation processes. Their most important goals are to ensure: the protection of water resources; best utilization of cultivated land, conservation of the environment and ecological balance; and local or original fishery cultivation, chicken, goat/sheep rearing and tree plantation. New technology and innovation will be introduced for benefiting the environment and agricultural output together and will be monitored for their impact on total ecological and agricultural development. Biovillage, therefore, represents an ideal model for everlasting sustainability of the economy, community development and environmental sustainability

The biovillage is a concept that generally gives us a clear view about an area or territory where people participate in environment friendly activities to maintain a safe and healthy life. Prime focus of bio-village is to encourage biodiversity, eliminate the use of industrially produced chemical pesticides harmful to human beings and to reduce dependence on chemical fertiliser through utilisation of organic manures/fertilisers while increasing production and income from farming. Essential features for an ideal bio-village are best utilisation of land resources, conservation of environment and ecological balance, composting, native fish cultivation, poultry rearing, tree plantation, etc. New technologies and innovations are practiced for creating impact of these on total ecological and agricultural development by utilising Integrated Pest Management (IPM) and bio-pesticides, emphasising on environment- friendly horticulture and crop production; ensuring health hygiene, fresh water supply and sanitation, infrastructure development and ensuring supply of energy, power and utility services. The pond culture

and fishery are also important component of the biovillage and its main goal is to integrate fish-duck farming. Farmers are also producing compost and vermi-compost. These compost and vermi-compost are collected to use as fish feed. These increase soil fertility and at the same time poor farmers are encouraged to produce more compost and vermi-compost and its utilization to increase their income and reduce organic wastes. Apiculture and bee keeping as income generating activities, tree plantation, bio pesticide, use of importance of medicinal herb planting are important features of this bio-village project.

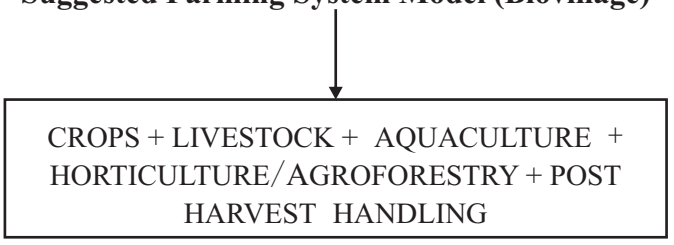
Need of setting a centre for rural development and management in Bundelkhand

Today in Uttar Pradesh especially Bundelkhand regions there are as many people below the poverty line and rural youths are also migrating from their native to urban areas. The gap between rich and poor is getting wider and wider, in the co-existence of unsustainable life styles and abject poverty and deprivation. The feminization of poverty has been increasing. There has been an expanding urbanization and the influx of environmental and economic refugees who have no livelihood opportunities in their native villages has caused a rapid growth of urban slums. It is distressing to see the high state of malnutrition amongst children, women and men. People also suffer from micronutrient deficiencies; they make up the army of "silent hunger. If Bundelkhand region will convince with the idea of establishment of centre of bio-village development and management then it will prove a resounding success in the up-liftment of socio-economic development of rural areas in general and agricultural sectors in particular of Bundelkhand regions. A significant portion of the entire population deeply depends on this sector to earn their livelihood. But the rising population of the country helps the disappearance of cultivable lands and for such a new approach is essential to address the growing demands in an environment friendly way. As a result, bio-village is emerging as a worthwhile solution to foster the agricultural development and conserve the ecological balance as well.

The centre will involve in training rural youths in various rural agro-technologies for development of Biovillage or Biovalley. The term Bio-village denotes the integration of recent advances in biological technology with the traditional techniques, in such a manner that the livelihood security of rural people can be upgraded ecologically and economically. The Biovillage development and management centre will promote the efficient and sustainable use of natural resources and to achieve a continuous and steady growth of agricultural production while protecting and improving the environmental capital stocks of the village. The major components of the bio-village include the various crops, livestock and human beings. Under this programme, rural youths and women could be encouraged to learn and implement activities as aquaculture, growing of edible mushrooms, horticulture, apiculture, fermentation, manufacturing eco-friendly vermin-compost and vermisol, goat rearing, biocontrol, bioenergy and poultry in rural areas. Learning such rural agro-technologies will enable them to establish their own cottage industries which will increase their income and substantially improve the rural economy. Therefore, the establishment of such centre for training of rural youths will encourage a value addition process within the system, to generate sustainable eco-jobs and income in the village. The rural youths could be trained in implementing various rural technologies including biotechnology tools such as use of biopesticides, biofertilizers, tissue culture and use of genetically modified improved seeds/planting material. Persons might be encouraged to start their enterprise in biotech areas utilizing locally available resources of livestock, water bodies, horticultural produces, medicinal plants and agro-wastes.

PROPOSED TECHNICAL PROGRAMME

Suggested Farming System Model (Biovillage)



The bio village model will orient its activities in two components:

1. Biovillage: Research & Development
2. Human Resource Development and Capacity Building

The centre will impart its role in the

1. Constitution of the model bio-village based integrated farming system.
2. Development of sustainable model for efficient resource recycling and environment conservation programme for rural rehabilitation.
3. Development and standardization of different farm practices under integrated farming system.
4. Devising exhaustive capacity building programme for enhancing the employability of rural youth.
5. Establishment of rural laboratories for assisting research, production and demonstration of agrotechnologies and/or rural bio-technologies.
6. Training of rural youths and farmers for adoption of various rural technologies to maximize the production of crops, vegetables and other crops by utilizing local bio-resources in meaningful and sustainable manner.
7. Development of general awareness programmes which could disseminate information about eco-friendly technologies which could increase the health, livelihood of rural people.

Among the many forms of technical assistance that centre will provide the following for the development and management of Biovillage are:

- Educating the rural population about health, hygiene, nutrition and village development and economic status
- Introduction of simple technologies for land preparation, crop care, crop harvesting, storage and handling
- Demonstration of enhanced horticultural gardening practices - including trickle irrigation and raised bed cultivation - and low-cost and small-scale energy technologies, like wind and solar-power equipment.
- Development of cottage industries that may find a market within the tourist trade
- Provision of technical 'how to' guides, mainly composed of illustrations with text in local languages and English.
- Offer a range of courses that addresses key issues of research, development, policy and management issues in rural development.

Besides, centre will follow four pronged approaches to fulfill the major goals of rural development through establishment of clusters of biovillages in the Bundelkhand regions:

1. To provide a unique platform of integrated approach for undergraduate students for value addition of their degree programme through the "Earn while you learn" mode with special emphasis on focusing rural empowerment
2. To provide post-graduate students with core development and research insights and impart analytical skills for planning and managing rural development programmes and also to develop student's capacities and infuse right attitudes, values and ethics.
3. To develop a committed and competent cadre of rural development management professionals in the country as village development manager.
4. To impart training of unemployed and deprived rural youths in the form of certification courses related to holistic development of hilly villages

The most important farsighted outcome of this centre will be making higher education relevant to social interface in the context of rural development, the students will have developed:

- Expertise in planning and management of rural development programmes with focus on participatory development and innovation
- Competence in reorienting the development delivery systems for improved delivery of services
- Sensitivity to the issues of equity and gender
- Appreciation of the rights and entitlements of the rural poor and the socially disadvantaged groups
- Right attitudes and values necessary for rural development professionals
- Positive thinking and leadership qualities.
- The principal features and detailed out lay of the biovillage model of sustainable and equitable

rural development will be developed after micro-planning of the site.

Outcome

- Optimization of local resources of rural sectors for the development of cottage industries in holistic manner for the improvement of economic and social status of unemployed and deprived rural youths
- Reduction of poverty and prevention of migration through creation of local employment through identification of factors contributing for improvement.
- Improvement of the nutrition, health and hygiene of villagers through education and development of balanced recipes as per availability of resources at rural level.
- Development of biovillage(s) through holistic development of rural biotechnologies and soft technologies through research, action research and consultancy efforts.
- Provision of equitable access to information and knowledge on agri-production and agri-business for creation of value added chains.
- Generation of research scientists and master's trainers for providing information about holistic models of biovillage development and management, improved technologies for upliftment of rural sectors through organization of skilled training for improving knowledge skills and attitudes of rural youths.

The bio resources in Bundelkhand region are enormous and there is vast untapped potential for enhancing production, productivity, value added products and export. The development of biovillage is essential for boosting up rural economy and thus overall economic growth of the Bundelkhand region thus can help in doubling the income of the farmers. The Biovillage model for rural development provides an alternative as it pays concurrent attention to natural resource conservation, productivity improvement and poverty eradication. However, it demands the skilled and trained manpower who can effectively address the effective requirements of a village for implementation of agro-technologies and/or rural biotechnologies as well conduct research on specific rural problems. Recognizing the need for competent manpower in this area, there is a need to establish a centre of bio-village development and management on integrated farming system in Bundelkhand to train the rural people. Learning such agro-technologies and/or rural biotechnologies will enable them to get employment in the form of village development officer who will help the rural masses in using all of their natural resources available to them to substantially improve the rural economy. In the emerging scenario, the area plays an important role not only in providing food-nutrition-health security but also provides avenues for livelihood options.

The discovery of agriculture was the first big step toward a civilized life.
The farmer works the soil. The agriculturist works the farmer.

- Eugene F. Ware

* * * * *

Earth is here so kind that just tickle her with a hoe and she laughs with a harvest.

- Douglas Jerrold

* * * * *

Agriculture is a fundamental source of national prosperity.

- J.J. Mapes

Increasing farmers' income in Uttar Pradesh: Interventions in livestock and poultry sector

R. K. Singh[1], Mahesh Chander[2] and Pijush Kanti Mukherjee[3]

The Prime Minister's call to double farmers' income by 2022 has brought renewed interest among stakeholders in the country, ranging from the agricultural research community, policy makers, state authorities, extension agencies, private players, and more importantly among farmers. The need of the hour is to give high priority to develop animal husbandry and poultry sector in order to improve the income of farmers through suitable interventions in breeding, feeding, management, disease control and marketing of livestock products

Introduction

Promotion of animal husbandry, poultry and fisheries has been envisaged as one of the major pathways towards Doubling of Farmers' Income (DFI) by 2022 across the country. The state of Uttar Pradesh - with diverse agro-climatic conditions - has high potential for agricultural and livestock development. It is a state where opportunities in agriculture and livestock sector outnumber the constraints in the productivity improvement. The state needs to give high priority to develop animal husbandry and poultry sector to improve the income of farmers through suitable interventions in breeding, feeding, management, disease control & marketing of livestock products as suggested in this article.

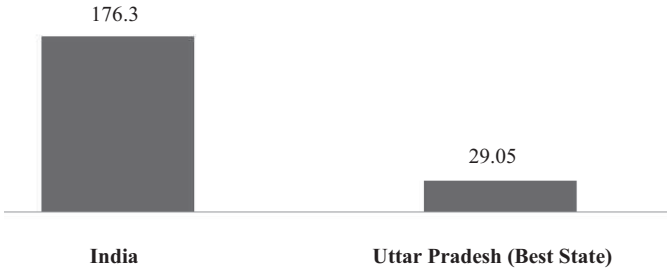
Livestock and poultry population

Buffalo is the predominant livestock species in Uttar Pradesh, accounting for 44.6% of total livestock population of the state, followed by cattle (28.5%), goat (23%), sheep (1.97%) and pig (1. 94%) as per 19th Livestock Census, 2012. Buffalo population in Uttar Pradesh is highest accounting for 28.17% of the total national buffalo population. Uttar Pradesh contributes only 2.55% to the total national poultry population.

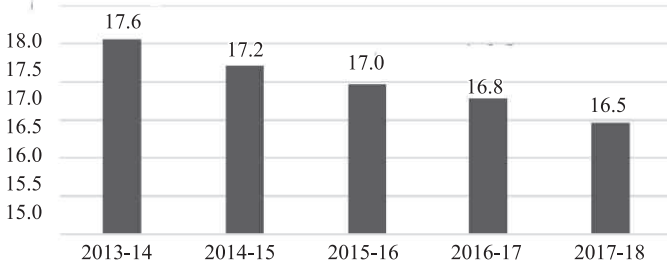
Milk production

Uttar Pradesh, considered as best state in milk production, contributes about 16.5% to the total national milk production per annum (2017-18). Percentage share by UP in total milk production is gradually decreasing with the progress of time. Milk productivity of cattle, buffalo and goat in Uttar Pradesh is approximately half in comparison to highest state Punjab. The per capita availability of milk in Uttar Pradesh (359 g/day) is almost equal with national figure (375 g/day), however, it is three times lower than that of the highest state i.e. Punjab (1120 g/day)

Total milk production (million tonnes) - 2017-18



Percentage share by UP in total milk production of India

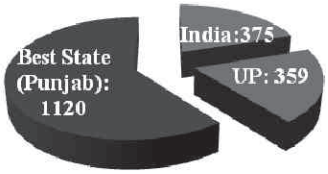


Egg production

Uttar Pradesh contributes only 2.6% to the total national egg production (2017-18). Egg production of Uttar Pradesh is approximately $1_{/8}^{th}$ of the highest state like Andhra Pradesh. Per capita availability of

[1]Director, [2]Joint Director (Extension Education) & [3]Principal Scientist
ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly-243122

eggs (11/annum) in Uttar Pradesh is substantially lesser than the national average (74/annum).

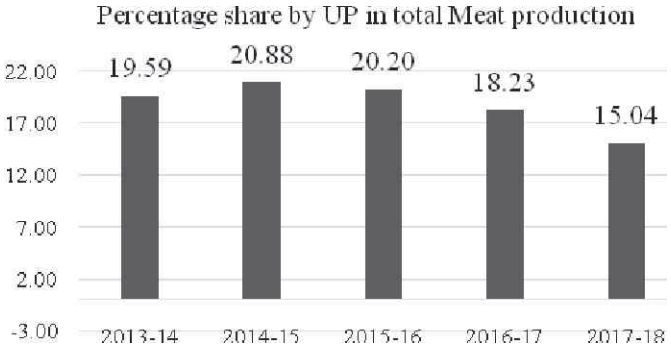


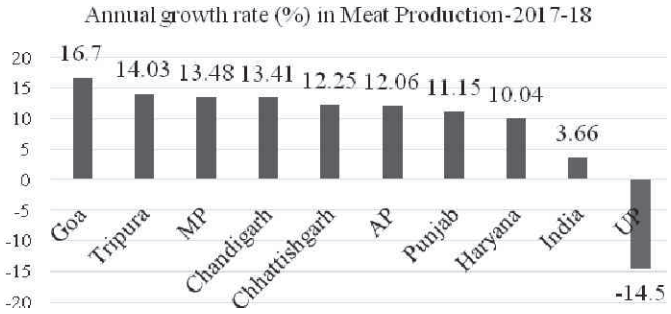
Per Capita Availability of Milk (gm/day)-2017-18

Per Capita Availability of Egg (no./annum)-2017-18

Meat Production

Uttar Pradesh, considered as best state, contributes 15% to the national meat production (2017-18) and the state is also contributing maximum share in export of buffalo meat from India. However, the state is showing decreasing trend in percentage share in national meat production and also recorded negative annual growth rate in 2017-18.





Key issues in livestock production

i) Low genetic potential and Infertility problem in cow and buffalo ii) Lack of availability of quality green fodder and area specific mineral mixture iii) Low success rate in Artificial Insemination (AI) in rural areas iv) Low level of technical skills, entrepreneurship of the farmers and poor success in crossbreeding programme v) Lack of preference for goat/sheep husbandry by small holders vi) Lack of slaughter facilities in the domestic trade especially in rural and remote areas vii) Inadequate Veterinary Infrastructure and livestock services delivery system viii) Lack of adequate cold chain facilities for effective vaccination especially in rural areas.

Key issues in poultry production

i) Low availability of good quality poultry germplasm ii) Loss of poultry birds due to pathogenic diseases particularly New castle disease, Fowl cholera etc. iii) Poor input delivery system iv) Inadequate cold chain facilities v) Inadequate capacity for proper hatchery management and feed formulation vi) Lack of new marketing strategies for augmenting sale of poultry and poultry products vii) Lack of organised cooperatives and cluster farming for better utilization of resources.

Intervention strategies

The Prime Minister's call to double farmers' income by 2022 has brought renewed interest among stakeholders in the country, ranging from the agricultural research community, policy makers, state authorities, extension agencies, private players, and more importantly among farmers. To this end, the major approaches include re-orienting focus, i) from intensification to diversification, ii) from sustenance to commercialization, and iii) turning the agricultural units to enterprises.

A. Overall intervention strategies in livestock and poultry sector

1. Feeding and health management are very important to harness the genetic potential of the livestock to maximum extent possible as well as to maintain the productivity of animals in dairy enterprise. Regular and timely deworming of animals against parasites, mass vaccination against the economically important major diseases (like Haemorrhagic Septicaemia (HS), Foot-and-Mouth Disease (FMD), Black Quarter (BQ), p*este des petits ruminants (*PPR*),* sheep and goat pox) and feeding management (entailing regular supply of quality green fodder, concentrate and mineral mixture) are very important. In the context of quality green fodder, $1/3^{rd}$ portion of crop land can be converted for

perennial fodder production in which Bajra Napier Hybrid has huge potential to maintain the supply of green fodder, especially during lean period.

2. The by-products of dairy sector can be taken to the business model of vermicompost production, which has tremendous potential of increasing non-farm income and side by side rural youths can be productively engaged in production and marketing of vermicompost.
3. Promotion of indigenous cows (Sahiwal, Hariana, Gangatiri and Tharparkar breeds, including Tharparkar in Bundelkhand Region) and buffalo, goats (Jamunapari, Barbari, Beetal, Jakhrana or Sirohi) as milch goat breed, strengthening AI service centres, establishment (and strengthening) of micro-level interface services for cow and buffalo management, ensuring timely availability of quality semen, developing semen sexing facility for increasing number of female calf/heifer, maintenance of cold-chain for vaccination and artificial insemination (AI) - especially in rural areas – constitute important steps in income generation.
4. Popularization of goat and poultry among small farmers including landless has high potential in the state.

- Promotion of goatary in South Western Semi-Arid zone and Bundelkhand region for increasing goat population and maintaining goat unit at 5:1 (Female : Male) ratio, development of kid nursery or Buck Mother Farm, and establishing nucleus flocks of goat through PPP mode will go a long way in augmenting the farmers' income
- Major thrust needs to be given to promote production of poultry [Broiler breeds – CARI-Tropicana, CARI Bro Dhanaraj; Layers Breeds – CARI Red, White Leghorn]; backyard poultry production [Dual purpose breeds – CARI-Debendra, CARI-Nirbheek, CARI-Shyama; Layer breed – RIR (exotic), Ankleshwar (Desi), Pure Desi Breed- Aseel, Kadaknath, Nicobari-for hilly and Tarai areas)] as well as Turkey and Duck [Duck-Khaki Campbell, White Pekin and Desi breeds like Indian Runner] as they have immense potential to enhance farmers' income
- Adoption of improved poultry production system like integrated duck-fish pond combination, wherein, excreta of the poultry dropped into the pond is used as feed for fish

B. Zone-wise intervention

1. Bhabar & Tarai Zone {Saharanpur (58%), Muzaffarnagar (10%), Shamli, Bijnor (79%), Moradabad (21%), Rampur (40%), Bareilly (19%), Pilibhit (75%), Shahjahanpur (6%), Lakhimpur Kheri (39%), Bahraich (47%) & Shrawasti (71%)}

i) Promotion of male buffalo calf rearing for meat production for export ii) Promotion of piggery iii) Popularizing commercial poultry farming iv) Management of infertility problem in cattle & buffaloes using Crystoscope and supplementation of immunemodulatory agents

2. Western Plain Zone {Saharanpur (42%), Muzaffarnagar (90%), Meerut, Shamli, Baghpat, Ghaziabad, Gautam Buddha Nagar, Bulandshahr & Hapur}

i) Promotion of broiler buffalo/male buffalo calf rearing for export purpose meat production ii) Popularizing boostermin (Area-specific mineral Mixture) supplementation in cattle and buffalo feed iii) Upgradation/replacement of non-descript buffalo breeds with Murrah breed iv) Promotion of commercial poultry v) Substituting aerated drinks with milk and milk products (like ghee, butter milk, flavored milk, srikhand, kheer, Lassi, Misti dahi, probiotic yogurt, yogurt branded with nutritious fruits etc.) as health drinks

3. Mid Western Plain Zone {Bareilly (81%), Budaun, Pilibhit (25%), Moradabad (79%), J.P. Nagar, Rampur (60%), Bijnor (21%) & Sambhal}

i) Promoting broiler buffalo/male buffalo calf rearing for export purpose meat production ii) Popularizing boostermin (Area-specific mineral Mixture) supplementation in cattle and buffalo feed iii) Upgradation/replacement of non-descript buffalo breeds with Murrah breed iv) Promotion of commercial piggery v) Promotion of Sahiwal

cattle vi) Substituting aerated drinks with milk and milk products as health drink

4. South Western Semi-Arid {Agra, Firozabad, Aligarh, Hathras, Mathura, Mainpuri, Etah & Kasganj (Kanshiram Nagar)}

i) Promotion of goatary for increasing goat population and maintaining goat unit at 1:5 (Male: Female) ratio ii) Development of kid nursery or Buck Mother Farm and establishing nucleus flocks of goat through PPP mode iii) Popularization of improved goat breeds (Jamunapari, Barbari, Beetal, Jakhrana, Sirohi) as milch goat having medicinal values for getting higher market price iv) Male buffalo calf rearing for meat production for export purpose v) Promotion of Bhadawari breed of buffalo for milk (with high fat) production

5. Central Plain Zone {Shahjahanpur (94%), Kanpur Nagar, Kanpur Dehat, Etawah, Auraiya, Farrukhabad, Kannauj, Lucknow, Unnao, Raebareli, Hardoi, Lakhimpur Kheri (61%), Sitapur, Fatehpur, Allahabad (58%) & Kaushambi}

i) Popularization of Sahiwal cattle breed ii) Commercial poultry as well as contract poultry broiler production iii) Promotion of commercial egg production iv) Substituting aerated drinks with milk and milk products as health drink.

6. Bundelkhand {Lalitpur, Jhansi, Jalaun, Hamirpur, Mahoba, Banda & Chitrakoot}

i) Promotion of goatary for increasing goat population ii) Development of kid nursery or Buck Mother Farm and establishing nucleus flocks of goat through PPP mode iii) Popularization of improved goat breeds (Jamunapari, Barbari, Beetal, Jakhrana, Sirohi) as milch goat having medicinal values for getting higher market price iv) Major thrust to promote poultry production including backyard poultry v) Promotion of Tharparkar breed of indigenous cattle for improving milk productivity vi) Establishment of cow shelters to tackle stray cattle/*Annapratha*

7. North Eastern Plain Zone {Gorakhpur, Mahrajganj, Deoria, Kushinagar, Basti, Sant Kabir Nagar, Siddharthnagar,Gonda, Bahraich (63%), Balrampur & Shrawasti (29%)}

i) Deworming against major parasitic worms including Fasciola ii) Timely Vaccination against FMD & HS iii) Commercial/contract production of poultry (broiler) iv) Commercial/contract production of pigs v) Promotion of egg production in commercial scale vi) Promotion of Gangatiri and Sahiwal breeds of indigenous cattle for improving milk productivity

8. Eastern Plain Zone {Azamgarh, Mau, Ballia, Pratapgarh, Faizabad, Ambedkar Nagar, Barabanki, Sultanpur, Varanasi, Chandauli, Jaunpur, Ghazipur & Sant Ravidas Nagar (86%)}

i) Commercial/contract production of poultry (broiler) ii) Commercial/contract production of pigs iii) Promotion of egg production in commercial scale iv) Male buffalo calf rearing for meat production for export purpose v) Area-specific Mineral mixture and other critical nutrients for productivity enhancement vi) Promotion of sheep husbandry for carpet wool and mutton

9. Vindhyan Zone {Allahabad (42%), Sant Ravidas Nagar (14%), Mirzapur & Sonbhadra}

i) Promotion of goatary for increasing goat population ii) Development of kid nursery or Buck Mother Farm and establishing nucleus flocks of goat through PPP mode iii) Popularization of improved goat breeds (Jamunapari, Barbari, Beetal, Jakhrana, Sirohi) as milch goat having medicinal values for getting higher market price iv) Major thrust to promote poultry production including backyard poultry v) Promotion of Tharparkar breed of indigenous cattle for improving milk productivity

The State Department of Animal Husbandry (SDAH) is the major stakeholder as far as the implantation of livestock developmental interventions are concerned, while the livestock research institutions can provide technological backstopping. These interventions may be implemented by the line departments to reap the benefits from the recommendations given above.

Potential of fisheries (Aquaculture) in enhancing farmers income in Bundelkhand region

I. J. Singh and Ashutosh Mishra

Aquaculture has undisputedly been recognized to have great potential for better income generation of farmers compared to any other farming activity. Even the most popular conventional aquaculture production system- composite fish culture can easily outpace any agricultural production system for overall revenue generation. Fish culture in a rain deficient area like Bundelkhand may be viewed by many as a very wild thought but if developed and managed strategically it can be a very realistic and promising proposition for the region.

It is well recognized fact that integration of fisheries with agriculture can be of great help in generating additional income of farmers by reducing the input costs of agricultural production systems. Thinking of fish culture in a rain deficient area like Bundelkhand may be viewed by many as a very wild thought but if developed and managed strategically it can be a very realistic and promising proposition for the region. As fish production is totally dependent on water availability it may be considered as a major constraint for wide scale venture of aquaculture production in the Bundelkhand region. However, this problem can be solved through developing water harvesting and holding systems on extensive scale to be used for fish production and subsequently agriculture. It can be easily achieved through utilizing existing Government schemes for promoting fish culture. Such developments apart from supporting the fish production will also enhance availability of water for agricultural purposes. In addition these water holding systems may also be helpful in recharging the ground water level. It is well established fact that water from fish pond enriched with excretory products of fish like phosphate and ammonia is more beneficial for irrigation purposes than canal or ground water.By routing canal or ground water through fish ponds to agricultural fields has been found quite remunerative in increasing fish and agricultural production simultaneously along with reducing input cost by reducing requirement for nitrogenous and

Aquaculture has undisputedly been recognized to have great potential for better income generation of farmers compared to any other farming activity. Even the most popular conventional aquaculture production system- composite fish culture can easily outpace any agricultural production system for overall revenue generation. In an extensive composite fish culture system Rs. 1.0-1.5 lakh/ha/yr can be easily earned without any other input than the fish seed. In semi-intensive culture system with moderate input of organic and inorganic fertilizers and artificial feed income can reach to Rs. 4.0-5.0 lakh/ha/yr. Even in intensive culture systems with appropriate management practices quantum of income can reach to Rs. 8.0-10.0 lakh/ha/yr. Highly intensive monoculture of fishes like pangas culture with high inputs including regular water change can give an income of Rs. 20.0-25.0 lakh/ha/yr. Thus income through aquaculture may range from Rs. 1.0 to 30.0 lakh depending on technology and fishes used and also level of management practices.

With several emerging new fish production technologies based on less water utilization and their integration with agriculture production systems especially vegetable production in vertical and horizontal aquaponics systems can prove boon in enhancing income of farmers in Bundelkhand region. If developed and integrated properly with agriculture production systems fisheries has great potential to increase the farmers income even more than double. The fish technologies available which can be very well adopted in the region and have promising potential for increasing revenue generation are described.

College of Fisheries
G. B. Pant University of Agriculture and Technology, Pantnagar

Composite fish culture

In this system three to six species of indigenous and exotic major carps, compatible with each other, are cultured together. In three species culture system preferred fishes are Indian major carps-catla, rohu and mrigal. In four species culture system in addition to three Indian major carps above the exotic carp-common carp or amur carp is also included. In six species culture three Indian major carps above and three exotic carps- silver carp, grass carp and common/amur carp are cultured together. Stocking densities of these fishes under different culture systems and depending upon level of management can range from 3000 to 10000 fingerlings/ha or even can go upto fifteen thousand fingerlings /ha which will also determine the quantum of income generation ranging from minimum Rs. 1.0 lakh to Rs. 10.0 lakh/ha/yr. In areas where water availability is not a major problem high end stocking density and management practices can be resorted otherwise lower to moderate stocking rates and management practices can be preferred. Stocking materials i.e. advanced fingerlings can be reared at high density in less water volumes under shed during water scarcity periods especially summer for stocking in water harvesting ponds as soon as they get recharged with water on onset of monsoon. Practices of one time stocking and harvesting or staggered stocking and harvesting may be chosen as per financial options/ requirements. Stunted growth fingerlings tend to grow very fast when released in larger water bodies at low stocking densities and compensate the loss of growth experienced during high stocking density in smaller area with less water quantity.

Culture of air-breathing fishes

Air-breathing fishes have the capability of utilizing aerial oxygen efficiently with the help of their accessory respiratory organs also called air-breathing organs. Owing to this capability these fishes thrive well in oxygen deficient ponds holding less amount of water. Three varieties of murrels i.e. spotted murrel, striped murrel and giant murrel, magur, singhi and kawai are well recognized cultivable air-breathing fishes throughout the country. Smaller ponds with less depth holding less water are preferred for the culture of air-breathing fishes for better growth and production. Presently availability of seed of these air-breathing fishes in requisite amounts is a problem, however with the success of their culture seed production can be locally taken up later on. Air-breathing fishes are preferred usually for monoculture however magur can be included in poly-culture with carps. Culture of air-breathing fishes based on availability of natural fish food organisms has limitations, hence it has to be feed based for successful culture and production

Monoculture of Pangas and Tilapia

Culture of Pangas, an exotic catfish and tilapia all males especially GIFT (Genetically Improved Farmed Tilapia) are gaining momentum in recent years in the country. Pangas has very fast growth rate reaching to marketable size of half kilogram even within 3-4 months and crossing 1.0 kilogram in 6-8 months. Normally stocking density up to 30000 fingerlings/ha as advised but some fish farmers are stocking @20000-25000 fingerlings/ acre and are earning about Rs. 20.0 lakh per acre in eight months. It's culture is being integrated with paddy cultivation in such a way that borewell water is released in fish pond holding pangas at high density from where pond water is supplied to the paddy fields. As per claim of the farmer apart from income from fish production he is also saving 20% cost of inorganic fertilizers with 20% increase in paddy production. Pangas can be conveniently cultured in smaller size cemented tanks of 25'x25'x4' dimension with frequent water exchange. Its culture is totally feed based which accounts about 60-70% of total cost of production. However, 25 to 30% return on input cost in 6-8 months is easily feasible through Pangas culture.

Tilapia males grow faster than females and GIFT has even better growth than normal tilapia. It is a hardy fish and can thrive well in smaller enclosures with less water and high stocking density. Owing to its anatomical features good fillets can be obtained from this fish. These positive attributes are contributing to it's increasing popularity as candidate species for culture but normal tilapia seeds are most widely used as availability of GIFT seed is very limited. Country has only one authorized centre, Rajiv Gandhi Aquaculture Centre, Vijayvada for GIFT all male seed production. In earthen culture ponds tilapia is

capable of utilizing variety of food items but when cultured in cemented tanks it's culture is also totally feed based. It can grow to half kilogram (marketable size) in 6 months and one kilogram in one year.

Above aquaculture systems require modest to large volume of water for producing desired quantity of fish in unit area. However, some recently emerging new fish culture technologies developed with the objective of requiring less quantity of water may be more useful for Bundelkhand region. The only drawback with these technologies is that most of them are highly skill oriented for which proper training may be essential. These promising new generation technologies are- Re-circulatory aquaculture Systems (RAS), Integrated Re-circulatory and aquaponics systems, In Pond Re-circulatory System (IPRS),Biofloc Technology (BFT) etc. Conventional integrated fish farming with diverse agriculture production systems may also be useful for the region.

Re-circulatory Aquaculture System (RAS)

In re-circulatory aquaculture system water is repeatedly reused with very limited rejection of only 10% of water in each cycle. A typical RAS consists of ensured water supply mechanical, biological and ultraviolet filtration systems, regular oxygen supply and feeding through automatic feeders. It is installed indoor where it can function at optimum efficiency.Fish species and flow rate of water through tanks holding fish is most important determinant for the level of fish production. Flow rate is normally considered in the terms of number of times changes of total water in 24 hrs is carried out. More the desired production level higher the number of cycles of water exchange within 24 hrs is required. Selection of fish is also important as it determines the required package of operations for optimized fish production level. Tilapia is most preferred fish for RAS as it is has good growth in limited space and water volume at high stocking density and is amenable to varied artificial feeds. Depending upon fish species and level of management including water flow rate a production of 30-60 kg of fish/m^3 can be obtained in RAS. It also offers advantage for farm location near to market to reduce transport time and costs involved (Figure-1).

Figure 1: Re-circulatory aquaculture system

Aquaponics System

It includes intensive aquaculture system integrated with hydroponics. Water from aquaculture system, which is usually rich in ammonia and phosphoric components excreted by fish, is used for growing plants which in turn purify it by removing phosphate and ammonia to make it suitable for reuse in aquaculture. Aquaponics can also be successfully integrated with RAS. Fish effluent from RAS contains sufficient levels of ammonia, nitrate, phosphate, potassium and other secondary and micronutrients to support growth of the plants in aquaponics system. The selection of plant species in aquaponics system is related to stocking density of fish in tanks and subsequent nutrients concentration in aquacultural effluent. Water chestnut, lotus, lettuce *etc.* having low to medium nutritional requirement and vegetables (tomatoes, cucumbers *etc.*) having higher nutritional requirements perform better in a heavily stocked, well established aquaponic systems. There is a huge demand for organic produces in the country owing to reports of high levels of chemicals and toxic materials in the vegetables being sold in the market. The agricultural produces from aquaponics system being safe and free from harmful chemicals are preferred by consumers (Figure-2).

Figure 2: Aquaponics system

In Pond Re-circulatory System (IPRS)

In an IPRS extensive and highly intensive fish culture systems are operated simultaneously in the separate enclosures of the same pond. Only 2.5% of the total pond area is used for the highly intensive fish culture in enclosure of re-circulatory system within ponds while remaining 97.5% area is operated under extensive fish culture system. However, fish production from intensive culture unit remains as high as 10 times than the extensive culture part. All inputs like water exchange, feed, oxygen etc. are required only for intensive culture component while in extensive culture component fish thrives only on natural fish food based on effluent from intensive culture unit. Requirements of intensive unit include high fish stocking density, water flow in accordance with desired stocking density, oxygen supply and quality feed etc. Aggregation of fish excretory products in intensive unit for discharge outside into extensive culture unit is to be used as organic manure for production of fish food organisms there for consumption of stocked fish. Fish production in extensive unit is almost based on zero input cost as no feed or any other input is used and fish remain fully dependent on natural fish food organisms developing there by support from intensive unit effluent. Using grass carp as culture species in both intensive and extensive culture units of the one ha pond a production of 50 tons in intensive unit and 5.0 tons from extensive unit have been successfully demonstrated.

Biofloc technology for fish production

Biofloc technology is a technique of enhancing production of live fish food organisms and maintaining water quality in aquaculture system through balancing carbon and nitrogen in the system. It involves the retention of waste and using it to produce biofloc of natural fish food organisms within the culture system. This promotes nitrogen uptake by bacterial growth decreases the ammonium concentration more rapidly than nitrification. Bioflocs are the aggregates (flocs) of algae, bacteria, protozoan and other kinds of particulate organic matter such as faeces and uneaten feed. Each floc is held together in a loose matrix of mucus that is secreted by bacteria. Biofloc technology makes it possible to minimize water exchange and water usage with adequate water quality within the culture unit, while producing low cost bioflocs rich in protein, which in turn can serve as a food for cultured aquatic organisms most likely fish or prawn. Compared to conventional water treatment technologies used in aquaculture, biofloc technology provides a more economical alternative (decrease of water treatment expenses to the order of 30%) and additionally a potential gain on reduction of feed expenses. The efficiency of protein utilization is twice high in biofloc technology system when compared to conventional ponds. Requirement of limited water makes it a low cost sustainable system with great promise for future aquaculture development (Figure-3).

Figure 3: Biofloc fish culture system

Integrated fish farming

Integrated fish farming is a practice of low input cost and high return. It is a multi-commodity farming system with a common infra-structural base, in which more commodities are farmed together keeping the fish pond as nucleus in place of traditional fish farming. The basic principles involved in integrated farming are complete utilization of farm wastes, which are recycled into the fish pond to enhance the primary productivity. It is based on the concept that there is no waste and waste is only a misplaced resource which can become a valuable input material for another production system. Integrated fish farming provides better income options to small and marginal farmers. In fish farming a major proportion of operational cost (50-60%) of the total expenses is needed only for feeding management. The total income can be

increased by reducing the expenditure on input cost particularly on the feed through integrated farming. Various animal husbandry practices of domestic animals and birds such as dairy animals, pigs, poultry, ducks etc. and crop production practices such as vegetables, banana, papaya and sericulture can be integrated as subsystem of fish farming. The wastes of livestock and crop production systems could be recycled into fish pond to serve as fertilizer and some part as food for growing fish. This system is helpful in minimizing input cost and helps to produce more protein per unit area. In India and other countries, a number of integrated fish farming systems are in practice with integration of two, three or four commodities together. Following integrated - fish - farming practices are very common.

1. Livestock-cum-fish farming
2. Agriculture/Horticulture-cum-fish farming
3. Agriculture-cum-Animal husbandry-cum fish farming

In livestock-cum-fish farming, husbandry of most domesticated animals such as dairy animals, pig, duck and chicken have been reasonably successful. In agriculture/horticulture–cum-fish farming, paddy-cum-fish farming is more common. Under Agriculture-Animal husbandry-Aquaculture (AAA) system production of crops, vegetables, domestic animals and fish have been carried out successfully (Figures 4 & 5).

Integrated fish farming as a proven technology of low cost and high return has become much popular in most areas of the country and has been widely adopted by the farmers across the country.

Some of these fish culture technologies are very efficient in producing fish in large quantity using limited water volume by complete utilization of nutrients and natural food produced there. In these systems the quality of water is maintained throughout the culture period with minimum risk of diseases. Though in some of these technologies, the input cost is more but these are very efficient in producing substantial quantity of fish with minimum possible use of water.

Figure 4: Integration of fish- vegetable crops

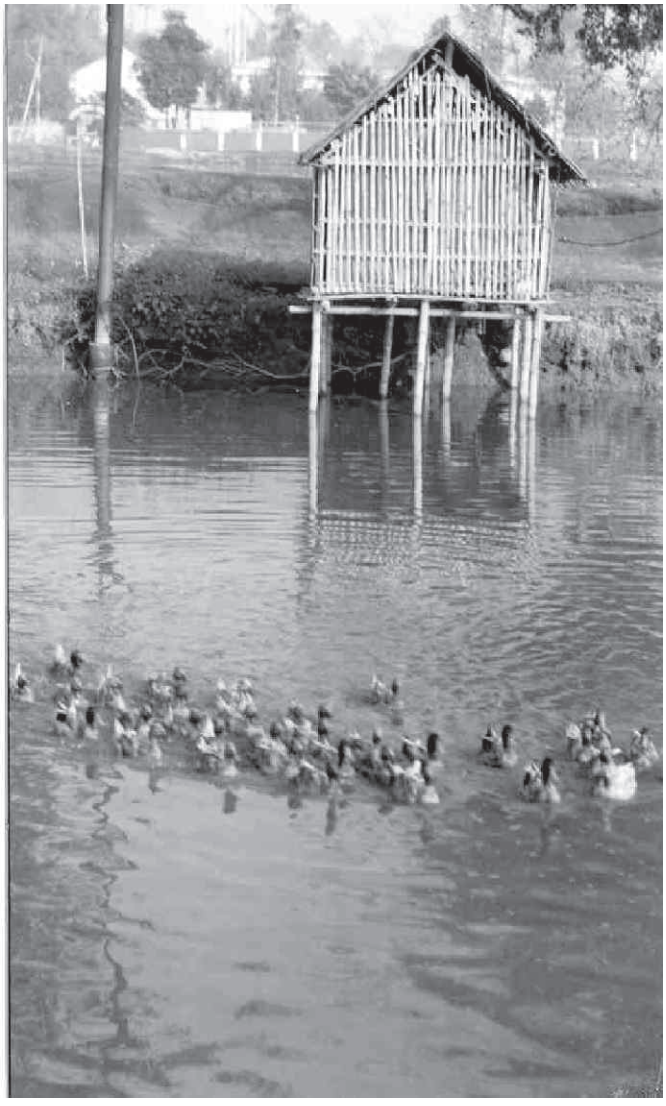


Figure 5: Duck-cum-fish farming

Crop diversification : An excellent farm technology for doubling farmer's income in Bundelkhand

K Rajarajan, S. B. Chavan, Hirdayesh Anuragi, Sukumar Taria and A. K. Handa

In India low level of farmer's income along with inconsistent productivity is a major agricultural discomfort. To secure future agriculture and to improve socio economic status and livelihood of farmers, adequate attention is needed. Achieving this objective will enhance farmer's income together with livelihood support. Doubling farmer's income is quite challenging but its attainable through various strategies related with development initiatives, technology and policy reforms in agriculture. Crop diversification is a potential technology for increasing productivity, nutritional value, ensuring food security and resilience to various biotic and abiotic stresses. This technology can also improve new market opportunities in local areas. In Bundelkhand region, appropriate crop diversification by high value crops, fruits, vegetables, floriculture, medicinal and aromatic plants and nonfarm enterprises, viz. apiculture, mushroom husbandry and value-addition could boost farmers' economy. This technology offers grow surplus products for sale at market and thus obtain increased income for their improved socio economic status.

Introduction

Bundelkhand region is a north-central India, where the people mainly engaged in agriculture and allied activities. In this region majority of people income is highly relied on farming based activities. However, due to climate change vulnerability, lack of awareness on new farming technologies and biotic stresses crop productivity is decreased, which ultimately leads to low level of income. Doubling income of farmer's still 2022 or over, required annual agricultural growth rate of more than 10 per cent against the present growth rate of about 2.1 per cent. This implies that the current and previously achieved growth rate has to be sharply accelerated.

This insufficient income becomes major constraint for their socio-economic improvement and livelihood security of many farmers in the country. The government has identified major sources of growth for doubling farmers income as; increase in productivity of crops, increase in productivity of livestock, increase input efficiency, increase crop intensity, crop diversification to high value crops, improved price realization by farmers and shift of cultivators to non-farm jobs. In this context, this paper demonstrates about crop diversification as a potential strategy for doubling farmer's income in Bundelkhand region.

Crop diversification and its importance

Crop diversification refers to addition of new crops or cropping systems to boost agricultural production on a particular farm in order to gain different returns from value-added crops with complementary marketing opportunities. It is perceived as one of the most ecologically feasible, cost effective and rational ways of reducing uncertainties in agriculture especially among small holder farmers. Besides, this technology aimed at enhancing plant productivity, nutritional value, health, quality and resilience to various biotic and abiotic stresses. In Bundelkhand region native vegetation is represented by a variety of species, such as grasses and grass like plants, shrubs and trees. Crop diversification in this region is an excellent strategy can help in doubling farmer's income by improving soil fertility, controls pests and diseases, yield stability, nutrition diversity and health. This technology also reduce the input costs by the farmers as reduced weed and insect pressures, reduced need for nitrogen fertilizers (especially if the crop mix include leguminous crops) and reduced erosion (because of cover crops inclusion). Compared to producing monocultures, management techniques for diversified crops generally consist of more sustainable natural resource practices. Major driving forces for crop diversification include;

ICAR-Central Agroforestry Research Institute, Jhansi

increasing income on small farm holdings, balancing food demand, withstanding price fluctuation, resilience to climate change, improving fodder for livestock, conservation of natural resources, reducing environmental pollution, reducing dependence on off-farm inputs, increasing community food security.

In Bundelkhand region crop diversification can be an excellent strategy for ensuring food security through diversification of food crops and which enables farmers to grow surplus products for sale at market and this obtain increased income to meet other needs related to household well-being. Primarily this area is semi-arid region, therefore crops which are suitable for dry land condition can be followed (eg. sorghum, ragi and pearl millet etc.) with appropriate crop rotation or intercropping can ensure food security and increase the farm income. The lists of important crops for crop diversification practices in semi-arid region are mentioned in Table 1. Besides this, diversification of commercial crops like cotton, sugarcane and vegetables also is an option for excellent farm income. These measures as crop diversification can enhance farm income as well as reduce the poverty as (i) lack of income and purchasing power (ii) lack of productive employment (iii) the continuous increase in price of food.

Table 1. Some of the recommended improved varieties for crop diversification in Bundelkhand

Categories	Crops/fruits/species	Varieties
Field crops	Greengram	Samrat, Sweta, Meha
	Blackgram	Uttara, Azad, Urd 2
	Groundnut	Amber, ICGS 5, Prakash GG 14, Girnar 2
	Wheat	LOK 1, MP 4010, Raj 1555
	Field Pea	Vikas, Adarsh, Ambika, Shikha
	Rapeseed-Mustratd	Kranti, NDRE-4, Urvashi
Fodder	Dinanath grass	Bundel-1, Bundel-2
	Cowpea	Bundel Lopia-1, Bundel Lopia-2, UPC-287
	Guinea grass	PGG-9, PGG-14
Fruit trees	Aonla	NA-6, NA-7, Kanchan, Krishna
	Ber	Gola, Seb, Umran
	Bael	CISH Bael-1, CISH Bael-2
	Guava	Sardar
	Pomegranate	Ganesh, Bhagawa

Crop diversification and new varieties

Crop diversification and adopting new varieties can be the best farm practice in increasing the farmers' income. Since, the objective of crop diversification is to increase crop portfolio and restricts farmer's dependency on monocrop to generate their income. Sometimes monocrop may be at high risks in the event of abrupt climate events that could severely impact agricultural production, such as emergence of pests and the sudden onset of frost or drought. In this circumstance adopting new crop species or varieties will enhance crop productivity through resistance to various biotic and abiotic stresses and also it helps in ecosystem stability and enhancing the biodiversity of defined area. The recommended farm practices for Bundelkhand are given in Table 2. Ultimately this technology will reduce the risk of total crop failure and provides an alternative source of generating farm income. Crop diversification in the form of fruits, vegetables, floriculture, medicinal and aromatic plants and introduction of nonfarm enterprises, viz. apiculture, mushroom husbandry and value-addition could boost farmers' economy.

Table 2.Some of the recommended farm practices for increase the farmer's income in Bundelkhand region

Enterprises	Existing Practice Average monthly net income	Recommended practice Approach	Average monthly net income
Cropping pattern	2860	Crop rotation with improved varieties	5005
Animals	416	Improved breeds; fodder banks	700
Non-Fram	262	SHGs and skill development	450
Wages/salary	1067	Capacity building	1867
Total	4605		8022

Source: Singh *et al.* (2018)

Conclusively, in Bundelkhand region crop diversification can contributes into improving productivity, improving socio economic status of farmers, resilience of farming systems and reducing carbon dioxide emissions. Also, in this area this technology will helps in increasing the income of small farm holdings, ensuring food security, poverty alleviation, increase the fodder quality for livestock animals and effective utilization of natural resources. Further adopting appropriate crop rotation and intercropping practices as a component of crop diversification will maximize the farm income in this region. It is highly required that research institutes should come with some other technological breakthroughs for shifting production frontiers and raising efficiency to raise production and income of farmers substantially. Effective shifting farming towards high value crops integrated with appropriate credit support, smart farming as well as policies implementation with minimum support price (MSP) reform can further helps in income enhancement of farmers in this region.

It is impossible to have a healthy and sound society without a proper respect for the soil.

- Peter Maurin

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Agriculture was the first occupation of man, and as it embraces the whole earth, it is the foundation of all other industries.

- Edward W. Stewart

* * * * *

If farm ecology and economics go wrong, nothing else will go right in agriculture.

- M.S. Swaminathan

* * * * *

Cultivators are the most valuable citizen.....they are tied to their country.

- Thomas Jefferson

Doubling income of the farmers in Bundelkhand region by utilizing crop and forest residue for solid fuel generation

Swapnaja K. Jadhav, Samlesh Kumari and Chirag Maheshwari

While agriculture in the predominant occupation in Bundelkhand, land available and used for cultivation in the region is considerably lower than in other agriculture zones of the country. Agriculture in Bundelkhand faces many challenges such as extreme weather conditions, like droughts, short-term rain and flooding in fields add to the uncertainties and seasonal migrations. The scarcity of water in the semi-arid region, with poor soil and low productivity further aggravates the problem of food security. Apart from size of land cultivated, agriculture production is primarily determined by availability of water and losses due to several diseases. Wheat and gram (chickpea) is the important and main cultivated crop in Bundelkhand region and are continuously suffer from many diseases that result in severe losses in yield. However, many pest management strategies are applied which are totally dependent on agrichemicals which put the environment and human health into danger. So, there is need to develop an alternative and eco-friendly way to control plant diseases and reduce the use of chemicals in agriculture.

Introduction

As we move in the rural area, despite of government policies regarding modern fuel like LPG, rural people are still using traditional fuel like wood, cow dung cakes etc. There is so much drudgery in collecting wood from forest, making of cow dung cakes by hand. Mostly, women have to do such work as it is related to domestic use. In wood cutting and collection, men are also involved in the process. Wood cutting is causing deforestation which eventually creates harm to the environment and it should be avoided.

There are other alternative fuels of which farmers are not fully aware about. In rural area agriculture is primary sector of earning. Plenty of crop and forest residues remain unused in the field. Farmers burn it to save time and cost of collection of the residue. Most of the farmers are yet to know about the biomass briquetting technology of conversion of readily available residue to the fuel, which will help them to earn more money and also reduce the drudgery in collection of the wood and making of cow dung cakes.

Biomass briquetting

This is the technology of producing densified fuel from biomass equivalent to the coal. Calorific value varies with the raw material used for briquette production. In this technology loose residue of low density can be converted in to high density solid fuel which becomes easy to handle. Various briquetting technologies can increase the density of any type of residue by 5 to 10 times. Residue can be pigeon pea stalk, chick pea stalks, cotton stalks, groundnut shells, forest foliage, sticks, forest grass which cannot be eaten by livestock, cow dung etc.

Availability of raw material in Bundelkhand region for briquetting:

Raw material from the Bundelkhand region can be in the form of crop residue, forest residue and cow dung.

Crop residue:

Though the 60% of crop residue is used for fodder for live stock, remaining residue can be converted into briquettes. Bundelkhand produce variety of crops so that the residue. Following table shows the major crop pattern in Bundelkhand.

Central Institute of Agricultural Engg, Bhopal.
Corresponding author: swapnaja20kjadhav@gmail.com

Table. 1. Major crop pattern in Bundelkhand.

	Cereals and millets		Pulses		Oilseeds		Fodder crops	
	1984-85	2003-04	1984-85	2003-04	1984-85	2003-04	1984-85	2003-04
UP Bundelkhand	51.7	39.1	40.2	55	5.4	4.1		0.5
MP Bundelkhand	57.8	32.5	23.5	37	10.8	17.7	8.8	

Source: District-wise Land Use Statistics, Ministry of Agriculture, Government of India, May 2008. Percentages derived from absolute figures. Total cropped area includes area cropped more than once (gross cropped area)

Forest residue:

Forests are found mostly in southern Bundelkhand. Forest residue can be available in Sagar, Panna, Chatarpur, Damoh, Tikamgarh and Chitrakoot districts. Forest land in Bundelkhand is very less. However, local communities are constantly using forest for their livelihood like collection of fire wood, collection of mahua, bamboo, glue, jamun seja, karaundha etc. These people can be involving in forest residue collection.

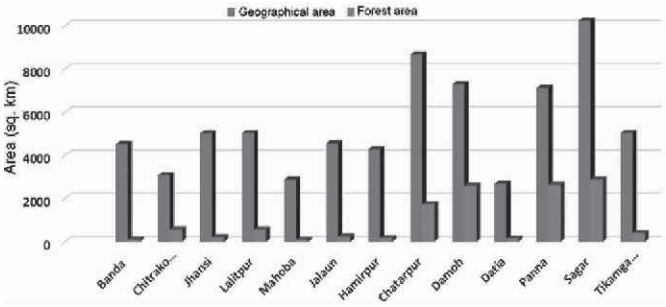

Fig. 1. Geographical area and forest area in Bundelkhand region of Uttar Pradesh and Madhya Pradesh.(Chavan, *et.al*.2016)

Cow dung:

Bundelkhand have the livestock population is about 0.8 per capita. Indigenous cattle and buffaloes followed by goats are the major livestock in Bundelkhand. Following table-2 shows percentage of livestock in MP Bundelkhand.

Table. 2. Percentage of livestock in MP Bundelkhand.

	% indigenous cattle	% buffaloes	% goats
MP Bundelkhand	49.59	16.79	20.62

(Source: Livestock Census of India 2003)

Almost all households collect the cow dung. Dung from the cattle and buffaloes are traditionally used for making manure and cow dung cakes to use as fuel in domestic sector for cooking. Cow dung cake making is very time consuming process. Women have to make it with hands. Collection of cow dung, making cow dung, drying it and storing it for further use requires rural women's 20% of daily time. Using briquetting machines this drudgery and time can be reduced (Fig. 2).

Fig. 2. Women making cow dung cake

(Source: https://www.youtube.com/watch?v=WY_FEeXEfSc Indian Trend Published on Dec 26, 2017)

Briquetting can be done using various types of biomass. Here is the list of technologies mainly fall into two categories with binder and binderless technology to convert crop and forest residue which are suitable for Bundelkhand area as follow.

1. Briquetting technology using binder

In this technology cow dung is used as a binder as it is readily available in rural area. In this technology, cow dung is used as a binder in the range of 10 to 30%, so that the cow dung will be available for other use as fertilizer or biogas production. Central Institute of Agricultural Engineering, Bhopal has developed two technologies to use crop residue foe briquette production using cow dung as binder which are listed below.

i) Crop residue briquetting machine:

In this machine, mixture of crop residue and cow dung is to be used. The crop residue should be

ground or chopped and reduced to the size of 5 to 20 mm. Then it should be mixed in the proportion of 70:30 and kept for overnight. In this process moisture will spread homogenously thorough out the mixture. This way crop residue will be pre-treated and ready for the use in briquetting machine. This machine has the capacity 50 kg/h of production. This machine comprises screw press which compress feed mixture and produce briquettes through the multiple dies of 30 mm size. These briquettes then have to sun dry and the dried briquettes are ready to use in chulhas. The calorific value of these briquettes ranges from 3700 to 3800 kCal/kg depending on the crop residue used. The technical manual will be provided with the machine. This machine is also available in tractor operated version (Fig. 3).

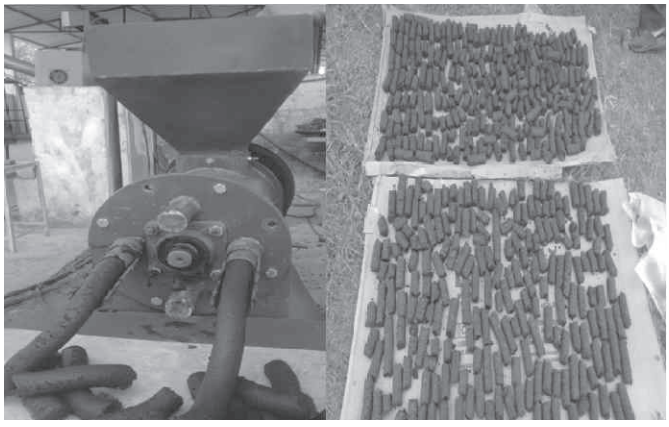

Fig.3. Crop residue briquetting machine and dried briquettes

ii) Charcoal briquetting machine:

This technology has two components, first is charcoal kiln and second is charcoal briquetting machine. Charcoal kiln is of 100 kg capacity. This is basically a drum having door with latch clamp. Any crop residue or weed without an size reduction has to be filled in the kiln then the crop residue is to be lit up. When crop residue start burning, the lid is to be close tight and then left for three hours. After kiln gets cold, charcoal can be removed from kiln. This charcoal has to be mixed with the cow dung in 70:30 proportion and used in the machine. The produced briquettes have to be sundry. Charcoal briquetting machine is of Rs. 50 kg/h capacity. These briquettes having calorific value in the range of 4000 to 4300 KCal/kg. This package has price Rs. 8000/- for charcoal kiln and Rs. 35000/ for charcoal briquetting machine.

1. Binder less briquetting technology:

This is a densification technology in which residue of size 0.5 to 20 mm is compacted under pressure of 5 to 60 MPa. A Briquetting machine allows you to compress wastes like sawdust, chips, sugarcane bagasse soy stalks, cotton stalks, groundnut shell and any other agro-wastes into briquettes that are environmental friendly and have high calorific value. These type of machines can be used for commercial purpose. There are different types of machines.

(i) Piston press briquetting machine: A piston press type briquetting machine designed for continuous heavy-duty operation with two load wheels. One of the load wheels acted as a pulley, and driven by the main motor through a flat belt. Initially dry and homogenous powdery saw dust in the form of raw material was fed through the screw conveyor to kupy by means of vertical screws, with its own-geared motor. It pre-compress and forces the material downward into the feeder box. From the feeder box the material is forced by the ram through taper die and due to high pressure and heat, powder form is converted into solid cylindrical briquettes. The briquettes produced from this machine are of size 20 to 90 mm (Fig. 4).

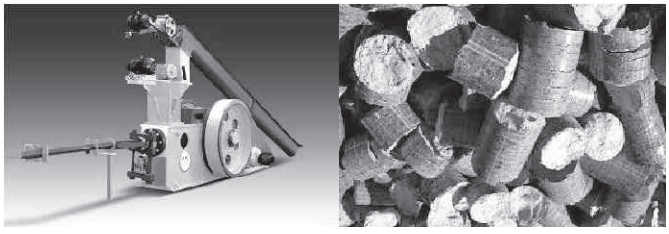

Fig. 4. Piston press briquetting machine and briquettes

(ii) Screw press briquetting machines: In a screw extruder press, the biomass is extruded continuously by a screw through a heated taper die. In terms of briquette quality and production procedure, screw press is definitely superior to the piston press technology. The central hole incorporated into the briquettes produced by a screw extruder helps to achieve uniform and efficient combustion and, also, these briquettes can be carbonised (Fig. 5).

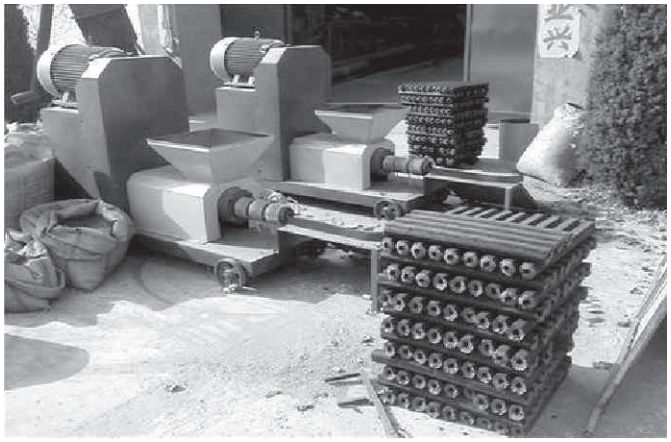

Fig. 5. Screw press briquetting machine and its briquettes.

iii) Roller and die pelleting machine:

The main component of Pellet Mill is a group of free rolling rollers with a flat round iron dye and grooves. The crop residue falls in the roller clearance from top to bottom, which enters the hole through the rotating force, then results in long cylinder size from the bottom of the die hole and cut into pellets by the cutter. As a result of the briquettes produced from this machine, the size of the palette is 4 to 12 mm.

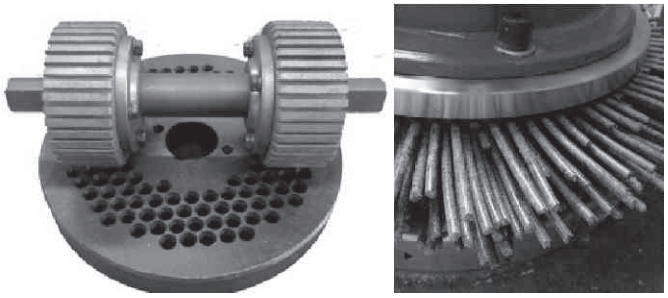

Fig. Roller and die pelleting machine

These machines are available in the market. Rural people can install these briquetting machines on individual or community basis. These briquettes can be used in traditional as well as in improved chulhas.

These briquettes have properties better than that of wood and cow dung cake. Crop residue briquettes have density of 650 to 1100 kg/m^3 and calorific value in the range of 3900 to 4200 kCal/kg. Such binder less briquettes has high demand from many industries for thermal applications and power plants. The average cost of production of such a briquettes is Rs. 2.5/kg and which can be sale at the average price of Rs. Rs. 6/kg. Such briquetting plants has payback period about six months.

The biomass briquetting plant is very suitable for Bundelkhand area as it will reduce the transportation cost of low density crop residue by 55 to 90%. The cost of briquetting is increased by about 70 to 130 % per kg of biomass briquettes during last 10 years. Marketability of the briquettes is very easy as almost all industries are interested in using bio fuel due to increasing price of fossil fuel in the future. Bundelkhand region have different industries which will require coal, this fuel will be supplement or the alternate for the coal. Government policies about briquetting plant are encouraging and farmers should take advantage of this. Briquetting technology serves many profits as an agriculture waste recycling including rural empowerment and establishment of briquetting plant will be always in profit as the supply of raw material will be from agriculture. The briquetting plant is a good opportunity for rural youth to entre in entrepreneurship.

If agriculture goes wrong, nothing else will have a chance to go right in the country.

- M.S. Swaminathan

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Agriculture is our wisest pursuit, because it will in the end contribute most to real wealth, good morals and happiness.

- Thonas Jefferson

Innovative techniques for successful establishment of new plantation in Bundelkhand region

Lal Chand*, Dhiraj Kumar, Asha Ram, Naresh Kumar, Sukumar Taria and Hirdayesh Anuragi

In Bundelkhand region, farmers having small land holdings, and the land resources of this region consists of red, black and mixture of soil types. The soil is inherently low in organic matter, shallow depth, poor water holding capacity, uneven topography, rocky subsurface, some pockets are prone to water logging during rainy season. The growing of fruit crops in this region can be a viable option for prosperity of the farmers, though production of fruit crops require some special attention at the establishment for sustainability of the orchards. The present article gives an initial inputs for successful establishment of new plantation in the problematic soils of the region.

Introduction

In Bundelkhand region, farmers having small land holdings, and the land resources of this region consists of red, black and mixture of soil types. The soil is inherently low in organic matter, shallow depth, poor water holding capacity, uneven topography, rocky subsurface, some pockets are prone to water logging during rainy season. This type of peculiar land resources require thorough attention for making the farming enterprise viable for the resource poor farmers of this region. The growing of fruit crops in this region can be a viable option for prosperity of the farmers. The production of fruit crops require some special initial attention for sustainability of the orchards. The present article gives an initial inputs for successful establishment of new plantation in the problematic soils of the region.

The available land resources for the production of food is shrinking due to population pressure, urbanization, industrialization in one way while deterioration of cultivable lands in terms of pollution, salinity, acidity, waterlogging, sub surface impervious layer, shallow depths etc., on the other way. Thus there arises such a situation, where, we need to explore innovative means to put degraded waste land into cultivation for the production of food to fill the belly of ever increasing population. Few of the Innovative techniques for successful establishment of new plantation in Bundelkhand region are being described here.

1. Innovative Plantation techniques:

Need of special plantation techniques:

In any of the plantation of trees or shrubs, the fore most important thing is to consider the site characteristics otherwise there are far more chances of its failure. The site characteristics include the climate of the area, soil type (depth, chemical and physical characters etc.), topography, vegetation, and other biotic factors. Apart from the above factors, the availability of labour, distance from market, local demand etc. matters a lot. Moreover, different planting techniques are there for different specific sites and to cater different site characters.

Deep Pit digging

In degraded cultivable land, deep pit digging and refilling provides an opportunity to replace degraded soils with a pit filling mixture prepared by nutrient rich soil, pond silt, river bed soil, fertile soil, well rotten FYM (Farm Yard Manure) etc. In shallow depth/degraded soils, a pit of 1m radius and 1.5 – 2.0 m depth can be prepared with the help of heavy duty machines like JCB, by blasting etc. Deep pit digging and refilling with well-prepared mixture provides a better environment to the plants to establish themselves in degraded problematic sites. Large pit digging in problematic soils are suitable for shallow rooted tree species those planted at wider spacing. Fruit tree species like pomegranate, mandarin, sweet orange, lime, fig, annona etc.

Dept. ICAR- Central Agroforestry Research Institute, Jhansi-284003 (UP)
**Corresponding author's email: godara.lal2009@gmail.com*

Trench digging

The trench digging method is applied for shallow soils, as it provides better space for rooting volume, to combat regular dry spells and droughts. This type of planting mainly suitable for shallow rooted fruit trees those planted at narrow spacing or high density orcharding like grapes, dragon fruit etc. and high density plantation of guava, papaya etc. can be raised in shallow depth soils by trench digging and refilling with well-prepared mixture of fertile soil, sand and FYM. Trench of 1 m width and depth and of convenient row length with the help of heavy duty trench digging and reaping machines. If the planting site having underlying layer of rackker soils/murrum or rocks which hinders the growth of tap rooted trees. If such sites used for growing large trees having strong tap root system like sapota, mango, guava, jamun etc. requires more soil volume for root growth. In such sites, after digging trench of above mentioned dimensions, the base of trench can be modified to break underlying hard pan or compact layer with the help of controlled micro blasting at the site of planting. Thus the blasted site can better release nutrients and helps in good penetration of water and improve root growth.

Raised Bed System for Plantation:

It is another alternative planting technique for shallow depth soils and water logging prone areas. For shallow sites, planting bed of a height of 50-70 cm, 2-2.5 m wide can be prepared by scrapping the surface soils of shallow depth site or by transportation of soil from other site to create ideal soil volume for rooting. This type of bed planting can be used effectively for shallow rooted tree species like sweet orange, mandarin, lime, fig, dragon fruit, grapes etc.

2. Moisture conservation techniques:

Mulching

Mulching has been practiced since long among farming community to conserve moisture, reduce weed infestation, reduce soil loss through runoff, wind velocity etc, temperature moderation and thus have better yield of good quality crop. Sand mulching, stone mulching and hey mulching are some of the conventional moisture conserving techniques practiced worldwide. Nowadays many colored mulches are available and practices in fruit production for various advantage over the traditional ones.

Sand mulch

The use of sand mulch has been practice since long. The main advantage of using sand mulch is that it is quite cheap, helps in smooth development of roots, better water penetration, the effect of applying fertilizers is quite improved on application of sand, the temperature moderation mainly during springs is better, the tillage operations on sanding is good. The availability of sand and its application is not cost effective.

Stone mulch

This is a primitive method of moisture conservation and weed management in landscape. It is easily available, easy to apply, fire resistance, lower cost,

Plate-1. Preparation of raised bed

Plate-2. Sand Mulching

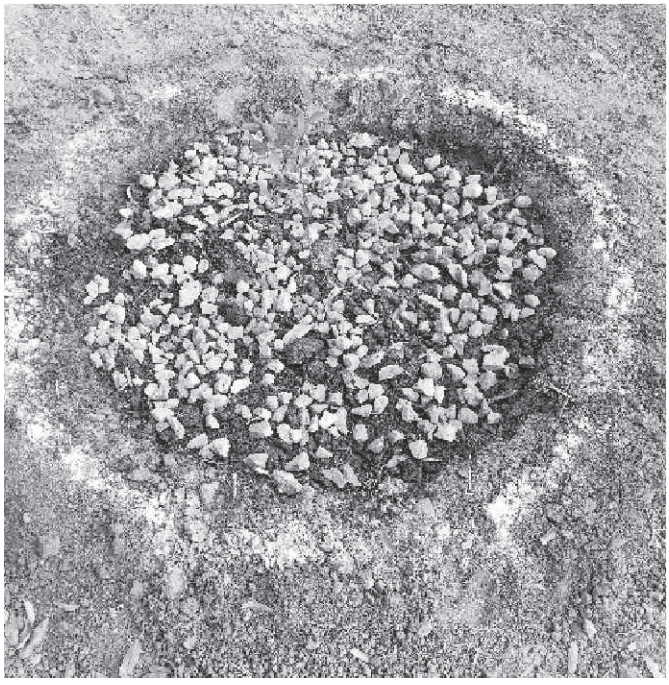


Plate-3. Stone mulching

better water penetration. It conserve moisture and reduce weed growth in and around the tree basin. The stone mulching can be used in combination of other water harvesting methods like full moon, half-moon basins etc. However, there are few disadvantages of stone mulching as it warm the soil in summer, create problems in field operations, not supply the nutrients to the plants, pH alteration by leaching from stones, removing it everyyear to apply organic matter/fertilizers.

Organic mulch

Most commonly used organic mulches are wood chips, bark shreds, grasses, tree leaves. It has several advantages viz., low cost, supply nutrients during decomposition, add organic matter, helps in soil biological activity proliferation, better soil physical and chemical conditions. The major disadvantage of organic mulch is it is needed in large quantity, need to be applied every year as it decomposes with time. There is problem of termites and other insects which can damage the tree root system.

Colored polythene mulch:

The colour of the mulch do affects the temperature prevailing above and below ground through the absorption, transmission and reflection of solar energy. This certainly affects the microclimate prevailing in the tree basin. The manner in which the mulch is in contact with soil surface also moderates the temperature.The better the warming better will be the effect. Scientists are using different colored plastic mulches to have multiple benefits to reduce mainly the weed effects, insect population and to improve fruit quality. The idea is to reflect different wavelength colors back to the lower canopy of the tree which otherwise not get proper sunlight, and thus there will be non-uniform maturity in the fruits and other problems. Thus to combat these issues, the colored mulches serve the basic purpose. The colored mulches are available in various shades like black, white, clear, silver/aluminium, silver/black, red, yellow and others.

Plate-4. Black coloured mulch

Woven mulch mate/weed mate:

Woven mulch mate have advantages over plastic mulch because it allow rain water penetration into the soil, it is quite strong and durable woven polypropylene for maximum weed prevention and have capacity to resist wind, porous and thus allow the anchorage of root growth. It is recent introduced mulch material which is used in nurseries, tree basins, pathways, drive ways, decking, plant beds, for landscaping etc. It is available in different colour combinations.

In-situ water harvesting:

Half-moon basin:

Half-moon micro catchments are small, semicircular earth bunds. In fruit crops, tree basins concealed by a semicircular earth bund of 30-40 cm width and height and 1.5 to 2.0 m away from the tree trunk to harvest rain water and conserve moisture. The half-moons catch water flowing down a slope. Half-moons are helpful to rehabilitate degraded land. The system is useful for sloppy lands.

Plate-5. Half moon basin

Full moon basin:

Full moon system is mainly suitable for levelled/flat land areas. In this system, around the tree trunk a circular earth bund created of 30-40 cm width and height and 1.5 to 2.0 m away from the tree trunk to conserve runoff water.

Contour staggered trenching: It consist of making a series of or trenches (3m x 0.5m x 0.5m) across the slope at convenient distance. The soil excavated from the trenches is deposited on the lower edge of the trenches where trees are planted.

Plate-6. Full moon basin

Contour bunding: Contour bunding consists of building earthen embankment at intervals across the slope and along the contour line of the field. A series of such bund divide the area into strips and act as barrier to the flow of water. As a result, the amount and velocity of run-off are reduced, resulting reducing the soil erosion. Contour bunding is made on land where the slope is not very steep and the soil is fairly permeable. Contour bunds are also called level terraces, absorption type terraces or ridge type terraces. For Bundelkhand region, where soil depth is very low, contour bunding is most suitable measure for soil and moisture conservation.

Plate-7. Contour staggered trenching

Establishment of new plantation in Bundelkhand region require lots of effort for their survival due to adverse edapho-climatic situation of the region. With the use of above mentioned plantation and moisture conservation techniques, the survival percentage of the new plantation could be increased to a significant extent.

List of figures : Plate-1. Preparation of raised bed, Plate-2. Sand mulching, Plate-3. Stone mulching, Plate-4. Black coloured mulching, Plate-5. Half moon basin, Plate-6. Full moon basin, Plate-7. Contour staggered trenching

Agroforestry based farming system– An ideal model of land use system on degraded land for sustainable development and livelihood security for doubling income of tribal farmers

Omkar Gupta

Natural resources are vital to meet the food, stable livelihood, and environmental security, attention has to be paid on conservation, sustainable development and economic growth of poor farmers, and management of natural resources. Fruit-based agroforestry system is an alternative land use system that integrates the cultivation of cash crops (vegetables, spices), and fruit trees components which provides significant opportunities for livelihoods improvement through nutritional and economic security of the poor people, reduction in distress and migration, and improves the quality of human life and soil health.

Introduction

Agroforestry not only has the potential of doubling farmers' income but carbon sequestration but also plays an important contribution in mitigation of greenhouse gas emissions. Environmentally, agroforestry practices can reduce erosion, improve ground water, moderate microclimate, enhance nutrient and provide wildlife habitat. Carbon sequestration is a phenomenon for the storage of carbon dioxide or other forms of carbon to mitigate global warming. We believe that agroforestry interventions provide the best "no regrets" adaptation measures in making communities resilient to the impacts of climate change and do discuss the same in relation to the challenges posed by the changing and variable climate.

Development Alternatives' Strategy

Based on the successful experiences of Tribal Development Programmes in Jhansi and Shivpuri districts of Bundelkhand region, Development Alternatives promoted small orchards, popularly called as 'WADI' – an Agro-horti based livelihood development with 1600 families in Sonebhadra district of Uttar Pradesh, India. The WADI developed as a 1 acre orchard with around 95 fruit tress which comprising of Mango (60) and Guava (35) plantation (spacing 8m x 8m), and vegetables/spices as main crop and the periphery is bio-fenced with forestry, fuel or timber species. A combination of cattle protection trenches and farm bunds around the periphery help conserve soil and water and keep grazing animals at bay. Fruit tree based production system offer suitable option for profitable utilization of the rainfed uplands. Long juvenile period, heavy mortality of the plants during the summer season due to grazing and lack of irrigation are two major factors, which discourage the farmers to take up mango & guava orcharding. Hence, development of a profitable fruit based production system with income from the first year onwards can help in alluring the farmers to take up fruit orcharding.

Key components of WADI model

- Soil and water management
- Orchard development
- Sustainable agriculture
- Fencing and border plantation
- Organic manure production
- Farmer producer organisation
- Women empowerment
- Health and nutritional sensitization

The key features of the WADI model

Approach – sound application of agriculture science

The WADI model employs scientific methods to

Senior Manager–Development Alternatives, Taragram
Email: ogupta@devalt.org

optimize production. The selection of appropriate orchard species is based on the analysis of agro-climate conditions, soil type, slope and drainage. High yielding and early fruiting varieties are adopted along with improved techniques such as integrated and organic farming systems. The seasonal crops for inter-cropping are selected so as to ensure crop rotation with one leguminous crop a year to enrich soil nitrogen levels. As the fruit trees grow, the growing canopy also influences the micro-climate making it possible to grow shade loving high value crops.

A better economic deal for farmers

The economic viability of the WADI model is proven. A typical WADI of 1 acre requires an investment of around Rs. 55,000/- including initial establishment cost and subsequent maintenance cost over 3-5 years. The financial returns in the first three years are only from the cash crops and range between INR 40,000-50,000 each year. The fruit trees take 3-4 years to mature and start yielding harvests adding an extra revenue stream. By the 5th year, the annual farm incomes go up exponentially to at least INR 1, 00,000-1, 50,000/- each year.

Rejuvenates the local ecology

The land and water management practices that form an integral component of the WADI model leads to a host of ecological co-benefits such as enhanced ground water recharge and reduced soil erosion losses. The plantation of trees leads to significant carbon sequestration. Established as clusters, WADIs also impact the micro-climate leading to improved local biodiversity. The use of organic fertilizers and pesticides and practices leads to gradual improvement in soil organic content and water holding capacity. The WADI model is climate resilient and can be adopted on partially degraded lands on which conventional agriculture is not possible and is therefore a suitable solution for reclaiming degraded lands into productive use.

Shobhnath, age 68 years, is a resident of Piparwaha Village of Chopan block of Sonebhadra district have been facing an issue of livelihood security, as a result

his family barely managing to eke out a living and had to migrate for wage labour to Dala, and Renukoot markets for daily basis. To address the above issue and improve the quality of life of his family, Shobhnath was introduced with agro-horti model 'WADI' and have been provided support with an opportunity to achieve a greater level of income enhancement through the integrated approach of a Agri-horti based livelihood model, that makes farming profitable even on small plots.

In 2016, he planted 60 Mango and 35 Guava saplings on his farm. Apart from this he also sowed seasonal crops. While his WADI was under development since he sold his seasonal farm produce and availed water resources (bore well) for irrigation of farm land. Watching his effort and change in mind DA further linked him to the Micro irrigation department, Sonebhadra. This agri-horti based model regenerates potential of the land and ensures Shobhnath's enjoy through a regular flow of income due to diversification of production.

He has graduated to growing vegetables, spices (turmeric, ginger), and oilseeds (groundnuts, mustard) along with Mango and Guava. The multitier cropping pattern ensures Shobhnath nutritional security by the provisioning of integration of farm model. The impact of the model is that Shobhnath paid his all debt and his daughter settled down after getting married. At present, Shobhnath and his family is proud of owner of full grown Wadi that is a model of sustainable development and livelihood security.

Promoting medicinal crops for agriculture diversification and livelihood in Bundelkhand region of central India

Meenakshi Arya

Dry land agriculture, as practiced in Bundelkhand region, is characterized by uncertain monsoon resulting in low crop yield. Inspite of irrigation facilities available in the near future, 60-70% of the land shall remain dry land and it needs to be exploited. Traditional crops are no more economical to the dry land farmers. Medicinal plants have higher demand in the market and found to be higher remunerative than traditional dry land crops.

The medicinal plants are in great demand since many pharmaceuticals industries need medicinal plant products as raw materials. Plants can be grown successfully in all agro-climatic conditions and are suitable for wide range of soils. Medicinal herbs have wider adaptability to the adverse climatic conditions. Some crops are best suited to the mixed and relay cropping. Medicinal crops don't warrant high land management of pest and diseases and can be cultivated as mixed or as sole crop.

Introduction

The Bundelkhand region lies at the heart of India located below the Indo-Gangetic plain to the north with the undulating Vindhyan mountain range spread across the northwest to the south. The region span across forteen districts: seven in Uttar Pradesh - Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda and Chitrakut, while seven in Madhya Pradesh viz, Datia, Tikamgarh, Chattarpur, Damoh, Sagar, Niwari and Panna. It covers an area of 7.08 million hectares (mha) and is located between $23^{o}20'$ and $26^{o}20'$ N latitude and $78^{o}20'$ and $81^{o}40'$E longitude (NGSI, 1989). According to the Inter-ministerial central team report on Drought mitigation strategy in Bundelkhand, about 8.8% of the geographical area of Uttar Pradesh, 26.2% of Madhya Pradesh and 21.4% of overall Bundelkhand is under forest and shrubs. About 50% of geographical area is cultivated and rest is categorized under various other land uses. Chickpea, lentil, sesame, mustard, groundnut, soybean, pea, urdbean, mungbean, wheat, sorghum, paddy, maize, barley, vegetables and fruits are the most important crops in the area under cultivation.

Bundelkhand has agrarian economy in which the principal source of livelihood and income generative activity is crop husbandry accompanied with livestock. The crop husbandry is primarily dependent on rainfall which is low as well as uncertain in amount and timing. Agricultural growth performance suffers from serious water availability constraint. Never-the-less it is understood that the region has a large untapped and technologically demonstrated potential that remains to be harnessed to spur agricultural growth through agriculture diversification, as in other rainfed areas of the country. There are a number of major and minor irrigation schemes being operated in Bundelkhand to provide irrigation water to farmers. Their success has however been insignificant compared to the grave socio-economic needs of the region. Bundelkhand farmers have been looking for some better alternative to diversify from traditional agriculture due to gradual reduction in profitability owing to decline in productivity, increased incidence of disease and pest attack in traditional crops. Contingent upon their hardy nature and higher returns, medicinal plant cultivation is a better option. If present level of area under cultivation can be sustained, the Bundelkhand region can make daunting contribution to achieve self-sufficiency in production of medicinal plants in near future if scientific cultivation practices are penetrated in the field. However, there will be need of aggressive

Scientist (Plant Pathology), RLBCAU, Jhansi
Email: meenakshirlbcau@gmail.com

extension and research for generation and dissemination of new varieties, integrated production and protection technologies for medicinal plants, accelerated quality seed production, farmer's centric policies, empowerment of growers through training, efficient transfer of technologies network, market, remunerative price and assured procurement. This will provide enabling environment for the region not only to become prominent hub for production of medicinal plants but also bridge prevailing huge realizable yield gaps with enhanced total factor productivity.

Why cultivate Medicinal plants

Dryland agriculture, as practiced in Bundelkhand region, is characterized by uncertain monsoon resulting in low crop yield. In spite of irrigation facilities available in the near future, 60-70% of the land shall remain dryland and it needs to be exploited. In India, out of the net sown area of 143 mha, the dryland accounts for 93.13 mha (68.4%). This dryland agriculture supports 40 per cent population, 60 per cent of cattle heads and contributing 44 per cent to the total food grain production in India. Coarse cereals, pulses, oil seeds and cotton are the principal dryland crops. Around 70 per cent of the population live in dry farming regions and their livelihood depend on success or failure of crops cultivated.

Traditional crops are no more economical to the dry land farmers. Medicinal plants have higher demand in the market and found to be higher remunerative than traditional dry land crops. These plants are quite suitable to our soils and atmosphere and the crops have got shelf life.The medicinal plants are in great demand since many pharmaceuticals industries need medicinal plant products as raw materials. Plants can be grown successfully in all agro-climatic conditions and are suitable for wide range of soils. Medicinal herbs have wider adaptability to the adverse climatic conditions. Some crops are best suited to the mixed and relay cropping. Medicinal crops don't warrant high land management of pest and diseases and can be cultivated as mixed or as sole crop.

In developing countries, wheretraditional medical systems prevail, the majority of people depend on medicinal plants to meet daily health needs. Industrialized nations also use medicinal plants, as ingredients to many pharmaceuticals. Acrossthe globe, many cosmetic and household products contain plants of therapeutic or medicinal value.It is estimated that 4 billion people, approximately 80 percent of the world's population, use herbal medicine in primary health care. In the US and Europe, the medicinal plants trade has been growing at an average of 10 per cent per annum among this vegetable medicaments have 30% market share. The global herbal medicine market is expected to reach USD 117.02 billion by 2024, driven by rising popularity of herbal therapeutics compared to conventional drugs. The market for herbal medicines and remedies is anticipated to record profitable growth due to their cost-effectiveness as compared to allopathic ones. Europe was the largest market for traditional medicines in the year 2016, contributing to 40.8% of the share and is expected to retain its leadership due to shifting from conventional drugs to herbal products. Additionally, ready acceptance of herbal products owing to its benefits is the key factor for market growth and is expected to play a significant role in future. The large European markets (Germany and France) are consolidating, while smaller markets show stronger growth. India is going to be a new market at a global level including Brazil, Argentina, Mexico, China and Indonesia. A study by the Confederation of Indian Industry (CII) reported the Ayurveda sector in the country will achieve a gross market size of USD $ 4.4 billion, or roughly Rs 30,000 crore by the end of 2018. To add to the bullish outlook, the Indian ayurveda industry is projected to record a compounded annual growth rate of a robust 16% until 2025. Some of the major drivers for the global herbal medicine market are rising elderly population, growing consumer awareness regarding the use of herbal medicines, slight or no side effects, and the release of Current Good Manufacturing Practices (CGMP) for dietary supplements by the FDA. Considering the economic importance of medicinal plants, there is an urgent need to systematically cultivate them to exploit their full economic potential.

Suitable medicinal plants for the region

RLBCAU has established garden having following species of medicinal plants as listed in Table 1.

Table 1: List of Medicinal plant in the University Medicinal Garden

Sr. No.	Local Name	Scientific Name
1	Ghrit Kumari	*Aloe vera*
2	Shyama Tulsi	*Ocimum sanctum*
3	Rama Tulsi	*Ocimum tenuiflorum*
4	Kapoor Tulsi	*Ocimum kilimandschaicum*
5	Jangali/van Tulsi	*Origanum vulgare*
6	Long Tulsi	*Ocimum americanum*
7	Vajradanti	*Barieria prionitis*
8	Ambi Haldi	*Curcuma arometica*
9	Ajwaoin	*Trachyspermum ammi*
10	Ashwagandha	*Withania somnifera*
11	Safed Musli	*Chlorophytum borivilianum*
12	Kali Musli	*Curculigo orchioides*
13	Meetha Neem	*Murraya koenigii*
14	Badam	*Prunus dulcis*
15	Rudraksha	*Elaeocarpus gaintrus*
16	Kala Dhatura	*Dhatura stramonium*
17	Aprajeeta	*Clitoriya ternatea*
18	Mint	*Mentha arvensis*
19	Karaunda	*Carissa carandas*
20	Sadabahar	*Cathoranthus roseus*
21	Vach	*Acorus calamus*
22	Dhatura	*Dhatura metal*
23	Fig	*Ficus carica*
24	Pomegranate	*Punica granatum*
25	Ghrit Kumari	*Aloe barbadensis*
26	MithiTulsi	*Stevia rebaudiana*

Out of these Ashwagandha - *Withania somnifera*, Kalmegh - *Andrographis paniculata*, Senna - *Cassia angustifolia*, Makoi - *Solanum nigrum*, Tulsi - *Ocimum sanctum*, Sarpagandha - *Rauvolfia serpentina*, Guduchi – *Tinospora cordifolia*, Gudmar - *Gymnema sylvestre*, Shatavarai - *Asparagus racemosus*, Langali -*Gloriosa superba,* Safed musli- *Chlorophytum borivilianum,* Mithi Tulsi- *Stevia rebaudiana* are most suitable to cultivate under dry land conditions.

Silvo-medicinal system for efficient resource use

Silvo-medicinal system is needed to reduce the pressure on the dwindling resources of the country, to obtain sustainable and regular supply of wood, fiber, fruit and medicinal products, to obtain good quality and genuine raw material for catering the industrial

demand, to improve the microclimate by lowering the surface soil temperature, to improve the soil physico chemical properties, to reduce the soil erosion and finally to increase the farm income. In silvo medicinal system, shade tolerant medicinal plants would be integrated as lower strata species in multi-strata system. It would be cultivated in a short cycle in the existing stands of the plantation crops and the medicinal trees as shade providers and boundary markers.

Tall and perennial medicinal trees areplanted at wide spacing in this system. The interspaces in between the trees are utilized growing agriculture or medicinal crops. Trees such as *Prunus africana, Santalum album, Saraca indica, Aegle marmelos, Anona squamosa, Emblica officinalis, Moringa, Sapindus mukorossi, Azadarichta indica, Terminaliachebula, Terminalia arjuna, Jatropha curcas* etc. can be intercropped with annual crops in early years until the tree canopy covers the ground. However, the time up to which intercropping can be done depends upon the spacing and nature of the trees grown.

Prospects

Though commercial cultivation of some of the species of medicinal and aromatic plants (MAPs) are picking up in India but still a lot of efforts are required to observe the real impacts of their cultivation. Impetus in terms of planning, funding, production, processing, and strong market linkage is essential to harness the potentials of commercial production of MAPs. Formal bio-partnerships between certified farmers and ayurvedic pharmaceutical companies need to be explored. The arrangement should ensure farmers with a guaranteed market and a fixed fair price for their harvest, in exchange for exclusive rights to the produce as the sole buyer. The other agencies like departments of forest, agriculture, horticulture, health and family welfare can come together to offer technical, market related and other input supply services to the various stake holders so that sector as a whole can grow. These constraints should be over looked in near future. Location specific systematic research on the introduction and developing the package of practices for medicinal plant would benefit farming community. Rani Lakshmi Bai Central Agricultural University, Jhansi has taken the initiative in collaboration with Bundelkhand University, Jhansi, to execute a project on promotion of value-added and herbal industry oriented cultivation of medicinal plants and their quality analysis for facilitating better industrial value for self-employment generation and sustainable development of farmers in Bundelkhand region with funding support from Department of Science and Technology, Government of India. The objective of this project is to promote cultivation of value-added and unconventional cash crop of medicinal plants for improvement of social and economic status of the farmers of Bundelkhand region.

Building resilient, integrated, mixed, multi-enterprise land use systems adapted to Bundelkhand region (rainfed, agro-pastoral, and irrigated) and markets is necessary to enhance farmer's income and livelihood. There is tremendous scope to introduce medicinal plants to build profitable farming systems in the region Bundelkhand that are climate resilient by tapping into the knowledge and enthusiasm of farmers and its rich heritage of plant biodiversity, which contains the inherent adaptive traits to climate change. There are also prospects to diversify and intensify silvo-medicinal systems and thereby close existing yield gaps, especially under rain-fed conditions. These medicinal plants could be efficiently involved in the cropping system and too as sole crops to increase the productivity and profitability by harnessing the demand of medicinal herbs. However, there is an imminent need for Capacity development of farmers with the skills needed to integrate cultivation of medicinal plants in their cropping systems with enabling policies for quality seed delivery, remunerative price and assured procurement for long-term success.

Non-conventional feed resources (NCFR) as a livestock feedstuff: A way to improve the livelihood of resource poor farmers in Bundelkhand region

M. C. Keerthi, N. Manjunatha, H. A. Bhagarvi, H. S. Mahesha and S. S. Manjanagouda

The central part of India comprises of Bundelkhand region which is ecologically diverse, rainfed, socio-economically heterogeneous, ethnically unique, agrarian and backward as compared to other regions. The hard rocky area with limited or inadequate ground water resources, low rainfall and infrastructure. Crop production, livestock rearing and seasonal out migration provide more than 90% of rural income. Crop residue provides 67% of the animal feed in the Bundelkhand region. In an independent survey by NGO-Swaraj Abhiyan has already been highlighted severe shortage of fodder in Bundelkhand region. Livestock sector in Bundelkhand region would continue to play a central role in providing livelihood security and coping mechanism to mitigate risks of the resource poor farmers. But, inadequate availability of quality feed resources has been one of the major constraint in enhancing livestock productivity in the region. Cultivation of dual purpose coarse cereal crops would enhance availability of crop residues, which are the major staple livestock feed resource in the Bundelkhand. The green fodder is mostly fed to milch animals which consist of annual grasses, legumes and improved fodder trees and shrubs. In spite of these attributes, use of improved forage in livestock systems is limited. Provision of forage of adequate nutritional quality is fundamental in ensuring increased livestock production. The need for cultivating green fodder in India is day to day need in rural sector in general and Bundelkhand in particular. Seasonal shortage of such feeds, especially during dry spells, further impedes growth of livestock sector. Livestock are being left for grazing (commonly known as annapratha) during lean season and also during rainy season. The deficit in fodder resulted an exorbitant increase in the prices of concentrate and crop residues. The higher cost of feed and fodder leads livestock sector is a challenging enterprise for landless, small and marginal farmers and their livelihood. Due to the shortage of fodder, farmers are feeding little quantity of green fodder to livestock affecting their health, breeding and milk yield. It is clearly indicated a major gap exists between the requirements and supplies of nutrients for feeding of animal. If the acute shortage of fodder supply is addressed, sustaining livestock will become extremely difficult and derail the rural economy completely. Majority of farmers are compensating the shortage of green fodder with concentrates, but it accounts 70% of input cost. In this context, the Non-conventional feed resources (NCFR) could be best alternative. It refers to all those feeds that have not been traditionally used in animal feed or are not used in the rations. The non-conventional feed could partially fill the gap in feed supply and also reduce the feed cost. It is therefore good to examine for cheaper feed resources that improves the digestibility of low quality feed and also improve intake. Cultivation of Azolla and Cactus (Thorn less) are the best NCFR to landless, small and marginal farmers of Bundelkhand region. As these resources can be grown by aforesaid farmers, because these NCFR require little space and less water for cultivation.

AZOLLA: Azolla is a floating fern and belongs to the family of Azollaceae. Presently, it is established as a very good fodder supplement for dairy cattle, sheep and goat, poultry etc.

Nutrient composition: *Azolla* is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene) and minerals including calcium, phosphorous, potassium, ferrous, copper,

ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh-284003

Azolla (photo courtesy: Google)

Table 1: Nutrient composition of Azolla

Nutrient	% (DM basis)
Crude protein	21.4
Crude fiber	12.7
Ether extract	2.7
Ash	16.2
NFE	47.0
Calcium	1.16
Total phosphorus	1.29
Potassium	1.25
Magnesium	0.35

(Source: Alalade *et al.,* 2006)

magnesium. The details of nutrient composition as given in table 1. Cattle and ruminants and not monogastric. Therefore, Azolla is one of the most economic and efficient feed substitutes for livestock, a replacer of protein.

Cultivation: The standing water method of cultivation is widely practiced. Water bodies, ditches in the vicinity can also be used for production of *Azolla*. Setting up of Azolla fodder plot does not require expertise and farmers themselves can handle it with ease. If set up in backyard, the area should be leveled and lined with bricks. The side of the plots should be raised to enable the water to stand. Alternatively, the fodder plot can be in a pit with depth of 0.2 m. A polythene sheet is spread over the bed in such a way that 8-10 cm of standing water can be maintained. Width of the bed is maintained at 2 m to enable the cultural operation from both sides. Length may be varied depending upon the fodder requirement of the unit. Once the bed of size 2.0 m x 2.0 m is ready, about 12-15 kg of fine sieved soil is spread over the bed, which will provide nutrient to the azolla. About 5 kg of pre-decomposed (2 days) cow dung is mixed with the water, which provides carbon source for the azolla. About 40 g of nutrient mix (10 kg Rock phosphate, 1.5 kg Magnesium salt and 500 g of Murate of potash) is added to the azolla bed. The solution is fortified with micronutrient of desired quantity. This not only takes care of the micronutrient requirement of azolla but also the cattle when it is fed with the azolla. Sufficient water is added to make the water level of the bed to 10 cm. Allow the tank to stand overnight. On the following day, spread around 200 g of fresh Azolla inoculum over the surface of the water. It takes about 12-14 days for Azolla to form a mat over the water surface. Water level in the tank should be maintained especially during summer months.Provide shade to reduce intensity of sunlight. Care should be taken about the source of the azolla seed. Initially, azolla will spread over the entire bed and will take the shape of thick mat within a week. Ideally it will give 10 kg of azolla within a week. After a week, 1 -1.5 kg of azolla can be harvested every day. Azolla should be harvested in plastic trays with sieve. Harvested azolla should be washed in fresh water before it is fed to the cattle. Washing is necessary to remove the smell of cow dung. Azolla harvested can be mixed with the commercial feed in 1:1 ratio. Cow dung and mineral mixture removed by azolla mass has to be supplemented at least once in seven days after harvest. A mixture made of cow dung, mineral mixture, soil and water should be added once in seven days. After every 60 days, soil is removed from the bed and another 15 kg of fresh fertile soil is added into the bed to avoid nitrogen build up and also provide nutrient to the azolla. Fresh inoculation of azolla after removing soil and water should be made at least once in six months repeating the whole process afresh. The production cost of 1kg of Azolla comes to around 50 to 90paise at present.

CACTUS (Thorn less) Thorn less cactus (*Opuntiaficus-indica*) commonly known as fodder cactus or prickly pear is one of the most important plants of Cactaceae family. It can be used both as a vegetable and valuable forage resource in arid and semi-arid areas. It is very suitable for those areas are characterized with high water deficit, low and erratic rainfall, frequent drought along with long and dry spells and poor soil.Large-scale plantation of cactus can provide a considerable reserve of animal feed during drought periods. Plantation of cactus in the marginal and unutilized land with proper initial care helped to combat erosion and desertification and provide feed for livestock during drought. A large portion of cactus pear plant biomass is vegetative material rather than fruits, and it can be fed to livestock as fresh forage not much work on. Silage cactus is available and not suitable for silage.

Nutrient composition:

The nutritive quality of Cactus depends on cladode age, season, and agronomic conditions.

Cacti cladodes are an unbalanced feed nutrient wise but a cost-effective source of energy and water. Cladodes are low in crude protein, fiber, phosphorus and sodium. Therefore, diets containing cactus should be balanced for these nutrients by appropriate supplements. The nutrient composition of thorn less Cactus as given in the table 2.

Cactus species which are used for animal feeding is easy and cheap to grow, palatable, and able to withstand prolonged droughts. Such characteristics make them a potentially important feed supplement for livestock, particularly during periods of drought and seasons of low feed availability. The cladodes constitute the majority of the biomass of cactus and can be fed to livestock as fresh forage not agreed. Animals can consume large amounts of cladodes. For instance, cattle may consume 50 to 70 kg fresh cladodes per day, and sheep 6 to 8 kg per day. Cladode consumption can have a laxative effect, leading to a more rapid passage of the food through the animal's digestive tract. This leads to poorer digestion, especially when the cladodes constitute more than 60% of the dry matter intake; supplementing with fibrous feed (e.g., straw or hay) can alleviate such laxative effects. The dry matter intake of straw steadily increases as the amount of cladodes supplied increases. The energy content of cladodes is 3,500 to 4,000 kcal/kg dry matter, just over half of which is digestible and comes mainly from carbohydrates. In arid and semiarid regions, cereal crop residues and natural pastures generally do not meet the nutrient requirements of small ruminants for meat production. Cladodes can provide a cost-effective supplementation, such as for raising sheep and goats on rangelands.

Thorn less Cactus (Photo courtesy: IGFRI)

Table 2: Nutrient composition (dry matter basis)

Nutrients	% or mg/kg (DM basis)
Dry Matter	10 - 11
Crude protein	11.81
Ether Extract	1.18
Fiber	8.12
Acid Insoluble Ash	2.55
Calcium	6.05
Phosphorus	0.30
Magnesium	3.15
Potassium	1.82
Sodium	0.05
Copper (mg/kg)	6.13
Zinc (mg/kg)	24.37
Manganese (mg/kg)	98.17
Iron (mg/kg)	257.54

(Source: NDDB, Anand)

Cultivation: Cactus is mainly propagated by cuttings or grafting. September-October and February-March are best time for planting. Planting is done before the onset of the rainy season to avoid rot in the cuttings. Selection of medium tolarge and healthy cladodes ensures a high number of active buds. Cladodes collected from the plants are dried under shade for 8-15 days. The cladodes are initially raised in plastic pots filled with potting mixture (1:1:1 sand, soil, farmyard manure), by keeping a one-third portion of the cladode under the soil and two-thirds above the soil surface. Erect planting keeping one-third portion of cladode below the soil found to give higher survival. In nutrient-poor degraded soils, 1 kg farmyard manure plant is recommended. Immediately after planting, 5 litres of water is added to each plant. Ridge or terrace planting is required, if the site selected has poor drainage provisions as cacti are unable to withstand waterlogging. For higher fodder yield, a dense planting of either at 3 m × 3 m or 2 m × 2 m should be adopted. To provide a nutritional balance, farmers are encouraged to grow leguminous fodder like lathyrus which is also capable of withstanding harsh conditions. Cactus is a tender crop and should not be grazed directly by animals a practice that could be highly destructive and drastically shorten the longevity of cactus plantations. Instead, cladodes should be harvested, cut into small pieces, and distributed to animals a 'cut and carry' methodology that is common in many cactus cultivating countries. Being, low in fiber and nitrogen, its effectiveness as a livestock feed can only be fully realized if it is mixed with other feedstuff, fibrous material, such as hay or cereal straws or shrubby legumes. The plant generates a high biomass of green forage in form of cladodes which are packed full of essential nutrients, reducing the intense pressure that livestock might otherwise exert on scarce water resources and other rangeland plant species. Its yield is 80-100 t/ha of cladodes as animal feed.

NCFR such as Azolla and Thorn less cactus have great potential for increasing green fodder production in bundhelkhand region and to provide a critical reserve of forage for animals in severe drought years. This in turn improves the economic status of landless, small and marginal farmers who are solely depended on livestock sector for livelihood.

A fertile soil alone does not carry agriculture to perfection.

- Elias Hasket Derby

* * * * *

Agriculture is at the core of the state.

- Dave Cook

* * * * *

Agriculture is the process of turning cco-systems into people.

- Toby Hemenway

* * * * *

A sustainable agriculture does not deplete soils or people.

- Wendell Berry

Increase in farmer's income through value addition of agricultural produce

Dinesh Pandey[1], Aparna Agrawal [1]and Anil Kumar[2]

In last few years, significant attention was paid on increasing the crop productivity by using latest technologies, quality seeds and agrochemicals in modern agriculture. This has made our country not only self sufficient in terms of food production but also exporter of major food products. However, no need was felt to increase the farmers' income during this period. Recently Government of India has taken initiative to double farmer's income by 2022. Among various ways suggested to double farmer's income, one way is value addition of agricultural produce. Value addition means making a food product more valuable by using strategies of Agroprocessing and modern sciences like Biotechnology and Nanotechnology. Value addition provides good price to farmers for their farm produce. Besides it is also important for treating malnutrition and lifestyle related diseases. It also gives employment opportunities to women and rural youths who can earn more by selling value added products. Therefore, there is no doubt that farmers can increase their income if they adopt value added agriculture instead of traditional agriculture.

Introduction

Previous strategies in the field of agriculture increased the crop productivity to the level that our country has surplus food production and become one of the leading food exporting country. However, our farmers remained poor and no attention was paid on increasing their income. According to a source, about 87% of farmers possess less than one hectare of land holding and earn very less money on selling their produce. This is due to surplus production and product wastage by various biotic and abiotic factors. As a result, most of the farmers have to work as laborers and some have to take loan to run their livelihood. Due to poverty, most of them had to commit suicide as they are not able to pay loan.

Fortunately, recently constituted doubling farmer's committee has realized the problem of farmers and suggested 7 step strategy to double the farmer's income by 2022. One of the strategy is to ask farmers to adopt value added agriculture in order to produce value added agricultural commodities which can provide more income to farmers than traditional food products.

Value added agriculture: need of hour

Value added agriculture refers to use of particular crop production process to increase food quality through processing and nutritional quality improvement. In this type of agriculture, other processes which involve packaging, processing, cooling, drying and extracting are also used to add value to food products. As a result of this agriculture, the nutritional quality of food can be increased and even such foods can treat nutritional disorders and life style related diseases.

At present there is high demand for such value added food products in the market. Therfore, farmers can earn more by selling their produce at higher price to consumers. These trends are creating employment opportunities for weaker sections of society especially women and rural youths who can establish small industries for the development and marketing of value added products.

How can value be added to agricultural produce?

Agroprocessing is very important for value addition because it makes the agricultural produce more nutritious. Besides Agro processing, various modern sciences like Biotechnology and Nanotechnology can also be used to convert agricultural produce in to the form which is most acceptable by consumers. Usually, with the help of such technologies, essential nutrients can be added to farm produce or organic agricultural commodities can be produced.

[1]Department of Molecular Biology and Genetic Engineering, College of Basic Sciences & Humanities,G.B. Pant University of Agriculture & Technology, [2]Director Education, Rani Lakshmi Bai Central Agricultural University, Jhansi

Value addition through Agro-processing

In general, Agro-processing aims at changing or transforming a product from its original state to a more valuable state. Agro processing includes a set of activities carried out for conservation and handling of agricultural produce and to make it usable as food, feed, fibre, fuel or industrial raw material. An agro-processing industry performs all operations from the stage of harvest of agriculture produce to the finaly developed product that reaches end users in the desired form.

Agro processing is basically of two types: Primary and Secondary processing. Primary food processing turns agricultural products, such as raw wheat kernels or livestock, into something that can eventually be eaten. This category includes products that are produced by ancient processes such as drying, threshing, winnowing, milling grain, shelling nuts, cotton ginning, oil pressing and saw milling. Secondary processing makes use of the products made from primary processing to make more valuable food products such as bread, biscuit, cakes, pastries and noodles, juice, jam, jelly, candies and sausages.

Indian traditional knowledge can be used in agro processing for the development of physiologically important functional foods. Indian traditional foods are not only healthy but also tasty with lot of health benefits. The way these are produced, the ingredients that they contain, and the presence of diverse microorganisms in these foods make them most valuable. The microbes and fermented traditional products have various functionas in maintaining human health.

High-value products containing flavour compounds (example: dawadawa) have been produced from traditional fermentations of locust bean. Idli, Dhokla, Dosa, pickles are famous examples of fermented products. Tofu produced from soy milk has lot of nutritive value. Development of these types of products from raw material of agriculture is important for both producers and market. Table 1 provides information about latest developments in the field of agroprocessing technologies.

Table1: Latest development in agro processing technologies in India

S.No.	Crop/Item	Recent products, processes, trends and technologies
1	Rice	Fully automatic modern rice mills Partially cooked/quick cooking rice Breakfast cereals and value-added products
2	Wheat	Fully automatic roller flour mills Whole bran wheat flour Fortified wheat flour Large number of baked products
3	Maize	Corn flour-packaged and branded Corn flakes and value-added products including ready-to-eat snacks (salted & sweetened) Starch material, corn oil with specific consumer desired attributes Cattle feed and Baby corn Large, automatic corn processing plants
4	Coarse Cereals	Value-added products including breakfast foods & extruded fortified tasty products Industrial raw materials
5	Pulses	Automatic processing units for pulses with driers, colour sorters and packaging unit Attractive consumer packaging with branding Cold storing of processed pulses Snack foods and other value added products
6	Soybean	Production of full fat soy flour/enzyme active soy flour for bakery and fortified foods Production of soy milk and paneer Ready-to-eat snack foods

Value addition through Biotechnology

Biotechnology is area of biology that uses living organisms or processes to manufacture products or technology to improve the quality of human life. Plant tissue culture technology plays important role in rapid multiplication of disease free planting material. At present, the plants of fruits and flowers such as strawberry, banana, mango, Gerbera and Gladiolous etc. are being made by micropropagation technology. Another important application of biotechnology is in development of transgenic crop varieties. With the help of recombinant DNA technology, a useful gene from one organism is transferred to a plant. These transformed plants with desired gene/character are called as genetically modified organisms or transgenics. There have been developed transgenic crop varieties which have high productivity, high resistance to insects and diseases, produce nutritive food for better digestibility for animals and humans. The shelf life of food products can also be increased. The cultivation of such crops allows farmers to grow more value added food on less land with less fertilizers and pesticides. The benefits of biotechnology are especially important at current time when our global population is growing and our demand for food is increasing, especially in developing countries.

During the past 15 years, remarkable achievements have been made in the development of transgenic varieties/hybrids in several crops. Transgenic varieties/hybrids of maize, cotton, soybean, potato, tomato, and papaya are now being commercially grown across 25 countries.

Flavr-Savr" tomato is the first commercially produced transgenic crop, which produce tomatoes which not only slow in ripening but also less susceptible to pathogen infection. Bt cotton and Bt corn are now commercially cultivated in a number of countries to control pathogen/insect infection. Farmers can reduce dependence on chemical fertilizers and pesticides and produce value added products using such crops.

Some other examples of value addition to agriculture produce through biotechnology are following:

- Carnation: Enhanced shelf-life, modified flower color, sulphonylurea, herbicide tolerance
- Melons: Delayed ripening
- Papaya: Resistance to viral infection, papaya ring spot virus (PRSV)
- Squash: Resistance to viruses infection and herbicide tolerance
- Sugar beet: Herbicide tolerance
- Tomato: Delayed ripening and softening, resistance to pests, lycopene rich tomato

Besides it, transgenic crops have been developed which produce food products containing vitamins and minerals. For example, transgenic rice containing iron in rice grains has been developed which can avoid anemia in women and children. Another example is Golden rice which contains carotene or Vitamin A that can prevent the problem of night blindness. Other examples of transgenic crops which produce food enriched with vitamins and minerals are presented in Table 2.

Table 2. Transgenic crops which have been genetically modified for vitamin and minerals

Crop	Nutritionaly improved trait
Canola	Increased Vitamin E content
Maize	Increased Vitamin E and C content
Potato	Increased ? carotene & lutein content
Strawberry	Increased Vitamin C content
Tomato	Increased Folate, lycopene and carotene
Carrot	Increased Calcium
Lettuce	Increased Iron
Maize	Increased Phytase and Ferritin
Soybean	Increased Phytase
Wheat	Increased Phytase

Application of Nanotechnology in Value added agriculture

The word nanomaterial is generally used for materials with a size ranging between 1 and 100 nm. These new materials are manufactured to have

unique physical or chemical properties, and have been applied in numerous ways in fields such as textiles, electronics, engineering, and medicine along with value addition to agriculture, livestock and in fisheries culture. Through application of nanotechnologies we can creating new food materials with enhanced properties.

Treatment of seed and water with nanoparticles/ materials can improve plant germination, crop growth, yield and quality of many crop products including cereal crops and cash crops. Nano particle treated seeds of rice, legumes, cabbage and cucumber have showed high germination rate, state, bud length, bud diameter and bud fresh weight in comparison to pure water (control) soaked seeds, Nano treated garlic showed 5cm longer bolts in comparison to control group. These techniques could also enhance the storage period for vegetables and fruits. Nanoparticle has a certain application prospect in the coating preservation of fruits. Nano-preserved fruit wax has a broad market prospect. These nano particle coated wax, not only has effects of common fruit wax preservation, fresh keeping, inhibition of water evaporation, and protection from microbial invasion, but also strengthens control of breathing, metabolism regulation, and anti-mold, which can greatly improve the perceptual qualities and market competitiveness of fruits.

Nanotechnology for nutrient delivery and nutrient enrichment of agricultural produce

Nanotechnology can be used to produce food enriched for particular nutrient or develop nutrient delivery vehicles. It has been observed that treatment of plants with metal nanoparticles enhances their growth and essential nutrient content. For example, wheat seeds treated with nano iron particles show improved shoot , root growth and also increases iron content of wheat seeds. Similarly rice seeds treated with zinc nanoparticles enhances zinc content of rice grains and increases biomass of rice plants. This treatment also prevents Khaira disease in rice which occurs due to zinc deficiency.

Lipid based nanoparicles (Liposomes) and polymer based nanoparticles can also be used as nano sized oral delivery vehicles which increase bioavailability of essential micronutrients. Nanodelivery vehicles can be synthesized by using edible plant parts which are also known as green synthesis of nanoparticles. In the lab, nanoparticles have been synthesized from spinach which can solve the problem of anemia. Nanoparticles prepared from turmeric have medicinal value. A nanodelivery vehicle prepared from prolamin protein of Finger millet enhances the uptake of fat soluble vitamins in human intenstine. These examples show how nanotechnology can transform agricultural products in to value added products.

To meet the food requirements of the increasing population in the next decades, both quality and quantity of agricultural foods must be increased. The development and promotion of high-quality and value-added agro-products are important for increasing farmer's income. Farmers must adopt value added agriculture to develop high quality food products keeping the requirements of consumers in mind. Agroprocessing is important component of value added agriculture which can help in converting the raw agriculture produce in to valuable food product. Even the crop residues and agricultural waste can also be processed to develop value added products.

Agriculture for an honorable and high-minded man, is the best of all occupations or arts by which men procure the means of living.

- Xenophon

* * * * *

A farmer is always going to be rich next year.

- Philemon

Entrepreneurship in soy food for employment and nutritional prosperity

Lalan K. Sinha[1] and Neerja Lalan[2]

Soybean is an excellent source of protein amongst plant proteins and has emerged as an important food crop in India, also known as "Golden Bean" because as it contains 40% good quality protein and 20% oil rich in polyunsaturated fatty acids along with good amount of minerals and vitamins. Soybean can be converted in to several value added food products such as soy flour, soy nuts, soy fortified biscuits, extruded snacks, soymilk, soy paneer, soy curd, soy fortified traditional foods, soy oil, soy sauce etc. Utilization of soybean as human food possessing excellent functional properties can make a significant contribution to nutrition at affordable cost and help in combating protein malnutrition among vulnerable group of the society.

Introduction

Soybean is an excellent source of protein amongst plant proteins and has emerged as an important food crop in India. It is known as "Golden Bean" because as it contains 40% good quality protein and 20% oil rich in polyunsaturated fatty acids along with good amount of minerals and vitamins. Additionally, it provides health promoting photochemical in high amounts and also contains good quality dietary fiber, which enables the human body to fight against diabetes. The growth of soybean in India has been phenomenal during last four and half decades India ranks fifth in production at global level. The major soybean growing states in India are M.P., Maharashtra, Rajasthan, Karnataka and Andhra Pradesh. Madhya Pradesh constitutes about 57% of the total area and around 65% of total production in the country and therefore it has been declared as soy state. Soybean can be converted in to several value added food products such as soy flour, soy nuts, soy fortified biscuits, extruded snacks, soymilk, soy paneer, soy curd, soy fortified traditional foods, soy oil, soy sauce etc. Utilization of soybean as human food possessing excellent functional properties can make a significant contribution to nutrition at affordable cost and help in combating protein malnutrition among vulnerable group of the society.

Enterprise for value addition and processing of soybean for nutritious products

Acceptance of soybean foods in India is increasing but at a slower pace as it is a new introduction to the food baskets of Indian people. Soy based food products can fit very well into various Indian food recipes provided it is properly processed and blended. Madhya Pradesh is the largest soybean grower state in India. The Centre of Excellence on Soybean Processing and Utilization, CIAE, Bhopal which is situated in Madhya Pradesh is promoting upcoming entrepreneurs to establish the soy processing unit for manufacturing and marketing of soy foods. The centre is putting all the efforts to accelerate the process of creation of awareness about the economic and health benefits of soy foods so that the unit will not only provide the income generating activities but also the livelihood opportunities to the unemployed upcoming entrepreneurs. This will not only provide employment opportunities to the owner but some more persons and help in eradication of malnutrition by making available the nutritious soy products in the area.

Soy enterprises for value added food products at cottage level

Realizing the importance of nutritious soy products for combating protein-calorie malnutrition in India and establishment of soy processing enterprise for nutrition security, livelihood and income generation

[1]Principal Scientist, [2]Ex-Chief Technical Officer & Training Coordinator (Woman Training)
Centre of Excellence on Soybean Processing and Utilization, ICAR Central Institute of Agricultural Engineering, Bhopal M.P-462 038, India

through entrepreneurship development training, Central Institute of Agricultural Engineering, Bhopal started a six day tailor-made regular entrepreneurship development programme on soybean processing to the upcoming entrepreneurs in 1995. The course content of the programmes is designed to provide hands-on training to them. CIAE has provided entrepreneurship development training to 2500 participants and about 200 cottage scale units have been established across the country for processing soybean into nutritious products.

Enterprise based on soy food products

New findings have indicated that the global goal of soybean processing and utilization is to strengthen the development of new foods for human nutrition and health. On account of increased health awareness among the people, there is a tremendous demand for functional foods that contain enhanced levels of phytochemicals which are beneficial for human health. In soybean, such phytochemicals for improvement of functional foods are present. Awareness on these aspects among masses is now spreading among upcoming entrepreneurs. The soy based food enterprise offers an opportunity for self-employment and income generation at micro or cottage scale. Operation of an economic activity by women related to soy processing for establishment of a food enterprise will generate an employment opportunities and thereby additional income for better life. Enterprise based on soy food products consists of various soy processing technologies. Out of various soy foods developed at Centre of Excellence on Soybean Processing and Utilization, CIAE, Bhopal processing technologies for soy milk and tofu (soy paneer), soy based biscuits and cake, soy nuts and full fat soy flour have good acceptance and there is a good demand for these products among the consumers.

Processing technologies for soy milk and tofu (soy paneer)

Soymilk is a nutritious substitute to cow milk. It is free from cholesterol, which is otherwise present in animal products. The absence of lactose makes it suitable lifesaving product for lactose intolerant people. The properly processed soymilk and its derivatives offer many neutraceutical and health benefits and are widely used in the orient. Soymilk can be used in almost any way that dairy milk is used. Soy dairy analogues may be composed of processed soymilk and its various derivatives such as tofu, flavored milk and beverages, yogurt/curd and derivatives, ice cream, etc. The soy paneer popularly known as tofu in the orient is a Japanese product made by coagulating soybean milk with calcium or magnesium salt and is generally used as a vegetarian food ingredient. It is a white, soft, gelatinous mass, which normally contains 78% moisture. The process it for making soy milk and tofu (soy paneer) is very simple.

Soymilk processing: Soymilk is essentially a water extract of soybeans, and the basic steps of preparation are: selection of soybeans, adding water, wet grinding and separation of soymilk from fibre (okra), cooking to inactivate lipoxyygenase and trypsin inhibitors, formulation and fortification, and packaging of the soymilk. The process for production of soymilk consists of soaking of soy splits for 4 hours, washing it before grinding. The grinder cum cooker is connected to the steam line from the steam generator. The steam is flushed in to the grinding chamber so as to drive away the air thus creating the oxygen less environment. The soaked soy splits (Fig. 1) along with some hot water is poured from the top hopper in the grinder and the grinding is started. The total water required for grinding is equivalent to six to eight times the wet of dry beans per batch is added along with the beans and then the inlet of the hoper is closed so that the air less environment is not disturbed. The grinding is done for 20 min and at the end of grinding the temperature in the grinder is maintained at 120^{o}C for 3 min. The

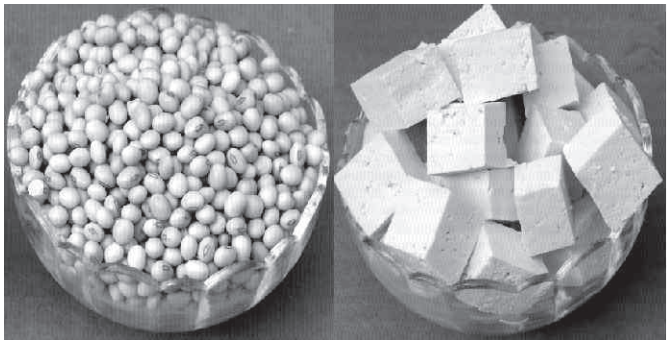


Fig.-1: Soybean and tofu from cottage scale plant

soy slurry is then taken out in the bucket and filtered through the muslin cloth, perforated cylindrical container under mild pressure in a specially designed filter. The filtered milk when hot (temp around 70^{o}C) is coagulated with coagulant. The coagulated material is pressed in the mechanical press for 30 min in the muslin cloth to remove the whey and give a desired shape.

Cottage level Soy milk and Paneer plant: The soymilk and paneer plant (Fig. 2) consists of a steam generator, a grinder cum cooker, an extractor and a paneer press. All these components are made up of stainless steel. The cost of this plant ranges between Rs. 2.75 and 3 lakhs depending on the manufacturer. The special feature of this plant is that it grinds and cooks soaked beans simultaneously under oxygen free environment and therefore the beany flavour in the end products is minimized and a better quality milk and paneer is obtained. The process time required is also substantially reduced compared to the process of grinding and cooking separately. The plant processes 2.5 kg of soybeans in a batch of 40 minutes resulting in 4 to 4.4 kg of soy paneer

Fig.-2: Cottage scale soy milk and tofu plant

Processing technologies for soy base biscuits and cake

Biscuits and cake, which are, ready to eat, convenient and compact in size; are capable of being enriched with additional proteins to enhance their nutritive value. Taking into account the longer shelf life and popularity of these products, their supplementation with soy protein was considered appropriate and the recipe and production technology for the same was developed. Usual ingredients for making biscuit and cake are flour, sugar, shortening, salt, milk, leavening agents, eggs and butter. Other ingredients are also sometimes added for variety. Addition of eggs improves volume, taste and flavour due to natural leavening effect and proportionally reduces the requirement of chemical leavening agents in recipe. The purpose of supplementation of soybean is for nutritional improvement of the bakery products. Supplementation of any food for nutritional improvement can be easily achieved by simply adding good quality protein-rich food raw material.

Formula and process for preparation of Soy supplemented biscuits*:* Biscuits are made by hand in almost all small bakeries and machines are used in the mechanized plant. In small units the dough is prepared by hand strokes, rolled in the form of sheet and cut with the help of dies/ biscuit cutters. The scrap is worked, rolled and reused. Baking is done normally in electric ovens until light brown. In large plants the dough is prepared in a mixer, fed into and moulded with the help of stamping or rotary biscuit roller and then to the travelling hearth oven. Biscuits are baked in the oven at 200-215^{o}C until light brown. By proper formulation of ingredients 30% (baker) incorporation of full fat soy flour in the formulae of biscuits and cakes along with other ingredients flour produces highly acceptable good quality biscuit and requires very little change in the manufacturing process (Fig. 3) and no changes at all in bakery equipment. The formulae and the process for making soy fortified biscuits and cakes are given in table 1 and 2, respectively. For making biscuits shortening and sugar are creamed together followed by gradual addition of baking powder & baking soda and mixing two minutes at slow, two minutes at

medium and two minutes at high speed scraping after each minute. Then soy flour, water & salt are added to creamed mass and mix for three at low speed. Finally refined wheat flour is added and mixed for 30 seconds at low speed scrapping at 5seconds interval After sheeting the dough is cut using the die of biscuit and baked at 200 degree centigrade for 15 minutes. For making cake shortening and sugar are creamed together followed by gradual addition and mixing of eggs and finally the rest of the ingredients during further mixing. The batter is poured in to a greased pan and at 190 degree C for 30 minutes. After adequate cooling cakes are sliced (5 cm x 7.5 cm) and dried in oven if rusks are required.

Table 1: Formula for soy fortified biscuits

SN.	Ingredients	Quantity % (baker's)
1.	Refined wheat flour (maida)	100
2.	Shortening (vanaspati)	40
3.	Sugar	40
4.	Baking powder	1
5.	Salt	1
6.	Sodium bicabonate (baking soda)	0.8
7.	Soyflour	30
8.	Water (ml)	32

Table 2: Formula for making soy fortified cake

Ingredients	Quantity (Baker's)
Refined wheat flour	100.0
Shortening	80.0
Sugar	80.0
Baking Powder	10.0
Salt	0.2
Egg	130.0
Water	20.0
Full fat soy flour	30.0

Product Quality

Soy fortification not only increases the protein content of the biscuit but also nutritionally improves the products. The nutrient-profile per serving for soy supplemented biscuits and cakes are given in Table 3. A soy-fortified biscuit weighing about 5 g provides about 0.6 g protein (almost 50% more than ordinary biscuit), 1.2 g fat and 25 kcal. Consumption of ten biscuits a day meets about13% protein requirement of a 10-12 year old boy and provides 210 calories whereas soy supplemented cake rusk per serving (5 pieces or 45g) provides 18.5% protein and 380 calories which contribute 44% of protein requirement and 16% of energy requirement of their Recommended Daily Allowance. The information is useful in deciding the quantity per service to achieve desired nutrition satisfaction level. The amino acid profile and protein content of the supplemented bakery products very well matches the pattern suggested by WHO (The World Health Organization) indicating higher amino acid scores.

Table 3: Nutrients and their dietary contribution in one serving against RDI for 10-12 years boy

S.No.	Nutrient	Nutrient-profile*		RDI**	Dietary contribution	
		Cookies	Cake		Cookies	Cake
1.	Energy, Kcal	210	380	2420	9	16
2.	Protein, g	5.5	18.5	42.5	13	44
3.	Calcium, mg	22	42	400	6	11
4.	Phosphorus, mg	75	137	400	19	34
5.	Iron, mg	1.4	1.9	25	6	8
6.	Zinc, mg	0.30	0.31	15	2	2
7.	Copper, mg	0.13	0.13	1.5	9	9

8.	Magnesium ,mg	27	28	350	8	8
9.	Thiamin, mg	0.08	0.10	1.2	7	8
10.	Raiboflavin, mg	0.07	0.04	1.5	3	11
11.	Niacin, mg	0.76	0.77	16	5	5

* Serving Size : cake rusk - 5 pieces or 45 g. ** Recommended daily Intake

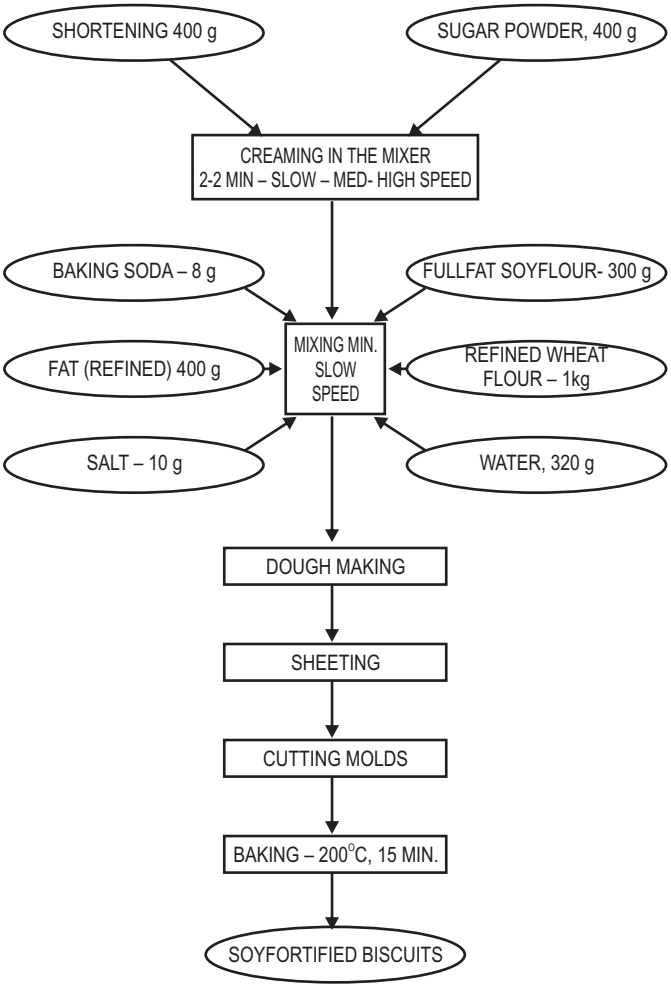
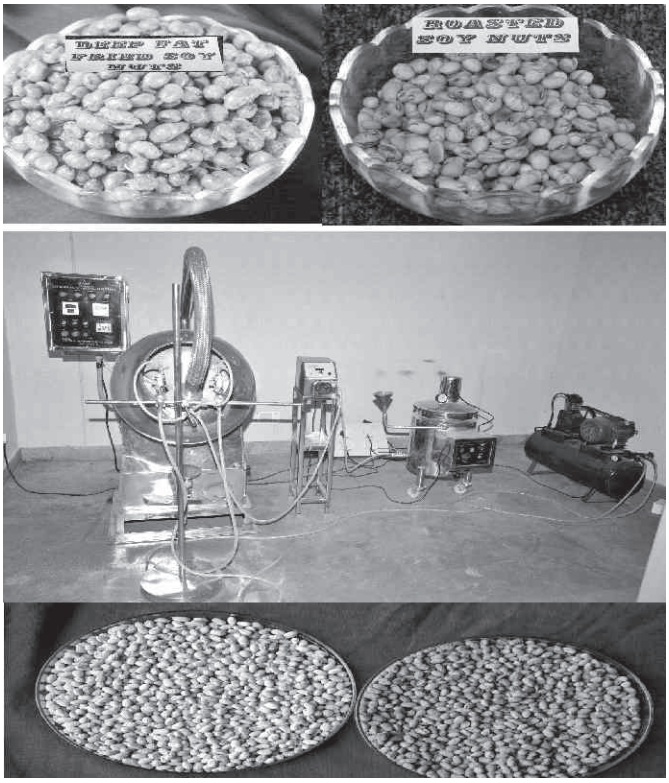


Fig 3.Process flow chart for production of soy fortified biscuits



Processing technologies for soy nuts

Soybean, one of the richest sources of quality plant protein, is being used as an ingredient in various food and pharmaceutical industries. Use of whole soybean in snack foods can enhance the nutritive value as a miracle ingredient as it contains around 40% of high quality proteins and 20% fat. It is low cost source of available plant protein and is affordable by the weaker sections of the society. Such snack foods can help in mitigating the problems of protein calorie malnutrition. Nutritious roasted and deep fat fried soy nuts have almost double the content of good quality protein in comparison to snack foods prepared from other pulses/legumes and provide over 540 kcal energy per 100 g of nuts. Enrobing of soy nuts enhances the acceptability of the product. Process for making roasted, deep fat fried and enrobed soy nuts from whole soybean and soy splits has been developed at CESPU, CIAE, Bhopal among other places. The process consists of soaking, pressure cooking, deep fat frying or roasting followed by enrobing. These nuts contain about 29.5% good quality protein and 31.7% fat providing over 540 kcal energy per 100 g of nuts. The special features of soy nuts are that it provides nutritious snack food having double the protein content in comparison to snack foods prepared from other pulses/legumes. The products have the following advantages.

1. Acceptable deep fat fried and roasted soy nuts are rich and low cost source of quality protein. Thus, the population of all segments can use it as *snacks*. It may be especially useful in nutrition programmes.
2. The developed deep fat fryer has uniform temperature profile throughout inside chamber and is suitable for better frying
3. Soy nuts will help in combating protein and energy malnutrition in rural area as well as for economically weaker section that can easily afford this.

The process for preparation of above soy nuts is very simple and can be followed easily by any entrepreneur or by any women in a traditional way for their household consumption. This will help in combating malnutrition.

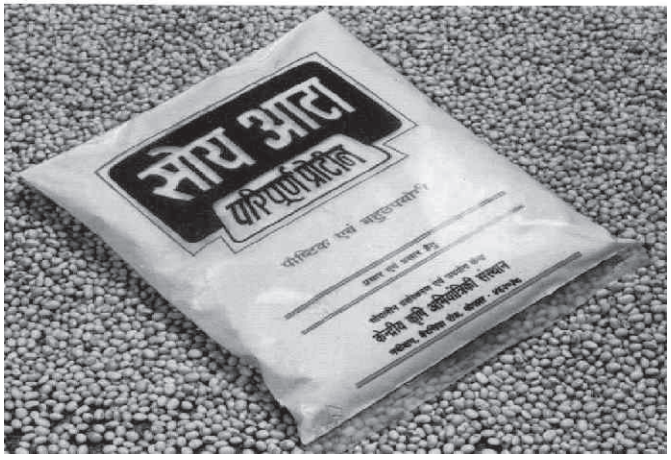


Fig. 4 : Full fat soy flour developed a CESPU, CIAE, Bhopal

Processing technologies for full fat soy flour

Protein calorie malnutrition is a serious health concern among Indian masses as our diets are cereal based. Cereals incorporated in the diets individually do not supply adequate good quality protein and calorie for satisfactory growth, body repair and maintenance. Therefore, protein supplementation of these diets is necessary to overcome the problems associated with the nutritional deficiencies. It has been reported that among all plant proteins soy protein is most attractive due to its abundance, low cost, better functional properties and excellent nutritional quality. Full fat soy flour in combination with any cereal or other pulse flour for preparation of traditional recipes is the simplest ways of using soy

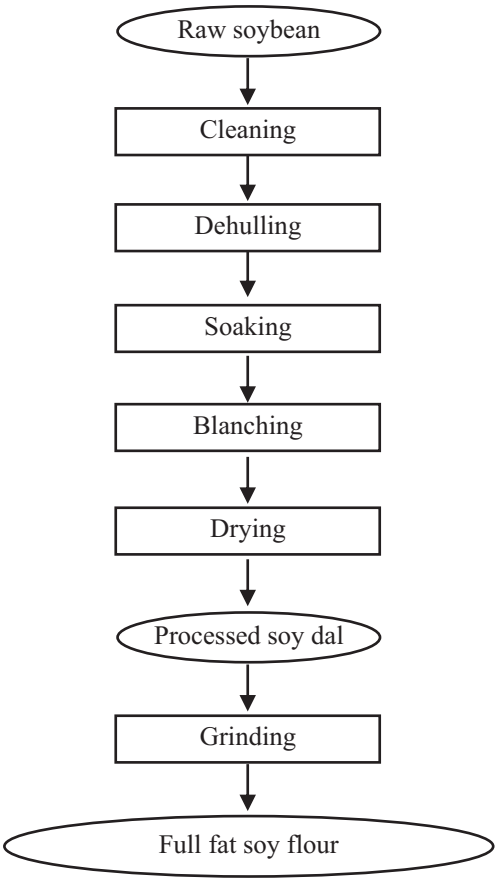


Fig.5: Process for production of full fat soy flour

protein in human diet. Preparation and use of recipes from soy cereal blended flour does not involve any change in the traditional food habits of the people. The full fat soy flour due to its nutritional and health benefits is getting popular among the masses (Fig. 4). Production of full fat soy flour at cottage level is very simple. The process flow chart for full fat soy flour is shown in Fig. 5. The cleaner and grader, dehuller, blancher, dryer, grinder, flour sifter, weighing machine/balance, heat sealer, storage bins, are required for the production of full fat soy flour. The process consists of cleaning, dehulling, soaking of soy splits in water with bean to water ratio of 1:3, blanching for 30 min, drying of blanched splits to about 8% moisture, milling in hammer/burr mill, packaging in polythene bags (400 gauge and above) or in metallic containers and storage up to 3 months (if needed) and utilization along with cereals. The major constituents of full fat soy flour (Fig. 2) passing through 30-mesh sieve are protein 40%, carbohydrates 22%, oil 20%, fiber 5% and minerals 3%. The shelf life of packed soy flour in polythene

packet is up to one-month (Fig. 4). However, after opening of the packet, it should be consumed within 15 days. In case where consumers prefer to grind wheat and treated soy splits together for supplementation of wheat flour, 1 kg treated soy splits is mixed with 9 kg of cleaned wheat and milled so as to get soy-wheat mix flour. The full fat soy flour can be incorporated at 10% in any traditional or modern recipes for enhancement of the protein content and can be increased upto 20%. It can easily be used for preparation of chapati, poori, paratha, etc. and also any bakery as well as extruded products. Alternatively the full fat soy flour can also be mixed with besan in 1:1 proportion and used in preparation of conventional snack foods like sev, chakli, pakoda, etc.

Soy based enterprises could be established for processing soybean for soy milk and tofu (soy paneer), soy based biscuits and cake, soy nuts and full fat soy flour which have good acceptance and demand among the consumers. The full fat soy flour can be used in all the traditional recipes for nutritional enhancement. Soy nuts and soy supplemented biscuits can be consumed as snack foods whereas soy milk or tofu as dairy analogues. From one kilogram of soybean about 6-8 liters of cholesterol free soymilk or 1.5 to 2 kg soy paneer (Tofu) could be obtained. This milk is at par with cow milk and can be sold as raw for making curd and curd based dishes such as *sreekhand, amrakhand, lassi, butter milk* or chilled flavoured soymilk. All soy based food products are nutritious and can be produced at affordable cost. The techno-economic feasibility appears to be viable from financial aspects besides providing high quality and low-cost food items to the people. So far about 200 soy processing enterprises have been established in different parts of the country for production of nutritious soy based food products. This is not only providing the income generating activities and livelihood opportunities but also helping in eradication of malnutrition by making available the nutritious soy products in the area.

To make agriculture sustainable, the grower has got to be able to make a profit.

- Sam Farr

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Agriculture is the most healthful, most useful, and most noble emploment of man.

- George Washington

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When the Nobel Peace Prize Committee designated me the recipient of the 1970 award for my contribution to the 'green revolution', they were in effect, I believe, selecting an individual to symbolize the vital role of agriculture and food production in a world that is hungry, both for bread and for peace.

- Norman Borlaug

NOTES

Swachh Bharat Abhiyan

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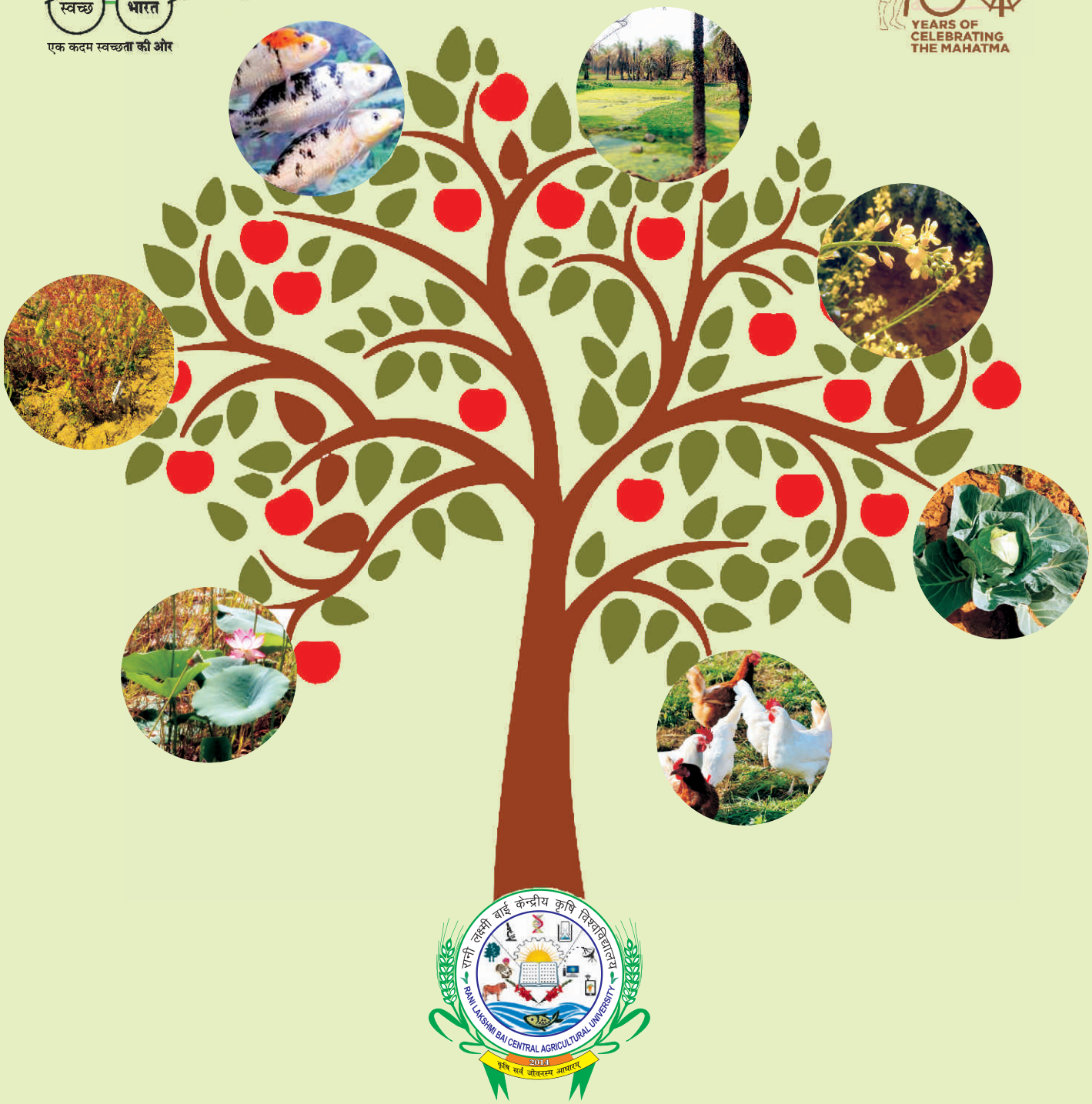
150 YEARS OF CELEBRATING THE MAHATMA



Rani Lakshmi Bai Central Agricultural University
Jhansi-284 003 (U.P.) India

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